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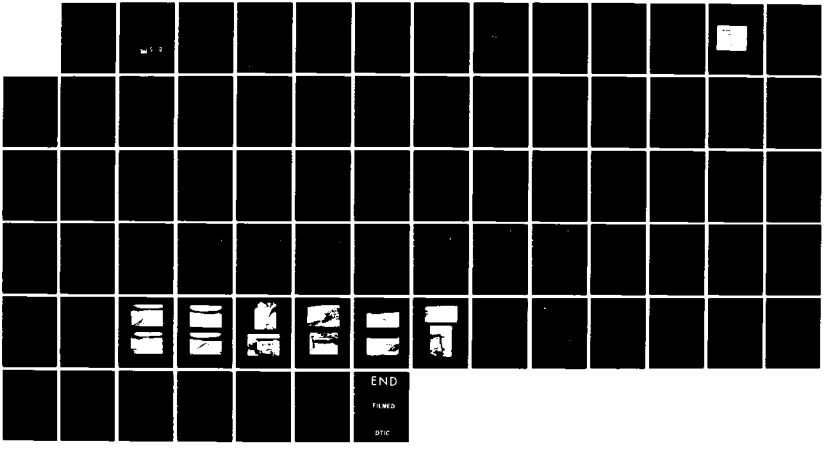

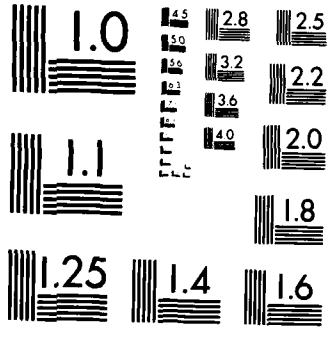

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MERRIMACK RIVER BASIN
BERLIN, MASSACHUSETTS

LESTER G. ROSS DAM
MA 01229

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JUNE 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
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Berlin, Massachusetts
North Brook, tributary of the Assabet River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The embankment has a maximum height of 44 ft. and is 5500 ft. long. There are deficiencies which must be corrected to assure the continued performance of the dam. Generally the dam is in good condition. There are boulders lodged in the main spillway and in the channel downstream of the impact basin. It is interrediate in size with a hazard potential of high.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

JUL 16 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Lester G. Ross Dam (MA-01229) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. I approve the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is vitally important.

Copies of this report have been forwarded to the Department of Environmental Quality Engineering.

I wish to thank you and the Department of Environmental Quality Engineering for your cooperation in this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

Incl
As stated

LESTER G. ROSS DAM

MA 01229

MERRIMACK RIVER BASIN
BERLIN, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA 01229

Name of Dam: Lester G. Ross Dam

Town: Berlin

County and State: Worcester County, Massachusetts

Stream: North Brook, tributary of the Assabet River

Date of Inspection: November 24, 1980

Lester G. Ross Dam is a 5,500-foot long earthfill embankment built in 1974 and presently used for flood control. The embankment has a maximum height of 44 feet and includes the dike, the main spillway/outlet structure, and an emergency spillway. The top of the embankment is at Elevation (El) 286.6 National Geodetic Vertical Datum (NGVD). The main spillway, located at the center of the dam, consists of a reinforced concrete drop inlet structure with an upstream intake. The total length of the spillway weir is 22 feet, with the crest at El 251.0. The intake is 3 feet wide, and is controlled by stoplogs between El 245.2 and 251.0. Discharge over the weirs and through the intake flows under the dam in a 48-inch diameter concrete conduit. The invert of the conduit is at El 245.0.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dam is in good condition.

The following deficiencies were observed at the site: seepage along the outside of the discharge pipe of the foundation drain at the dike; silt accumulation in the discharge pipe; minor erosion on the downstream slope of the dam, near the right abutment; animal burrow on the downstream slope of the dam; and boulders lodged in the main spillway and in the channel downstream of the impact basin.

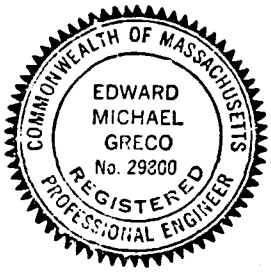
Based on Corps of Engineers' guidelines, the dam has been classified in the intermediate size and high hazard categories.

LESTER G. ROSS DAM

test flood equal to the probable maximum flood (PMF) was used to evaluate the capacity of the spillway. The test flood outflow is 9,100 cfs, resulting in a pond level at El 283.4 and 3.2 feet of freeboard. Hydraulic analyses indicate that the combined main spillway and emergency spillway can discharge 187 percent of the test flood outflow without the dam being overtopped.

It is recommended that the Owner employ a qualified registered professional engineer to investigate the seepage occurring along the pipe which discharges from the foundation drain at the dike. In addition, the Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also continue the program of annual technical inspections, implement a formal plan for surveillance of the dam during and after periods of heavy rainfall, and a plan for notifying downstream residents in the event of an emergency at the dam.

The measures outlined above and in Section 7 should be implemented by the Owner within a period of 2 years after receipt of this Phase I Inspection Report.



Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 29800

Approved by:

Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703

This Phase I Inspection Report on Lester G. Ross Dam (MA-01229) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechmical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

LESTER G. ROSS DAM

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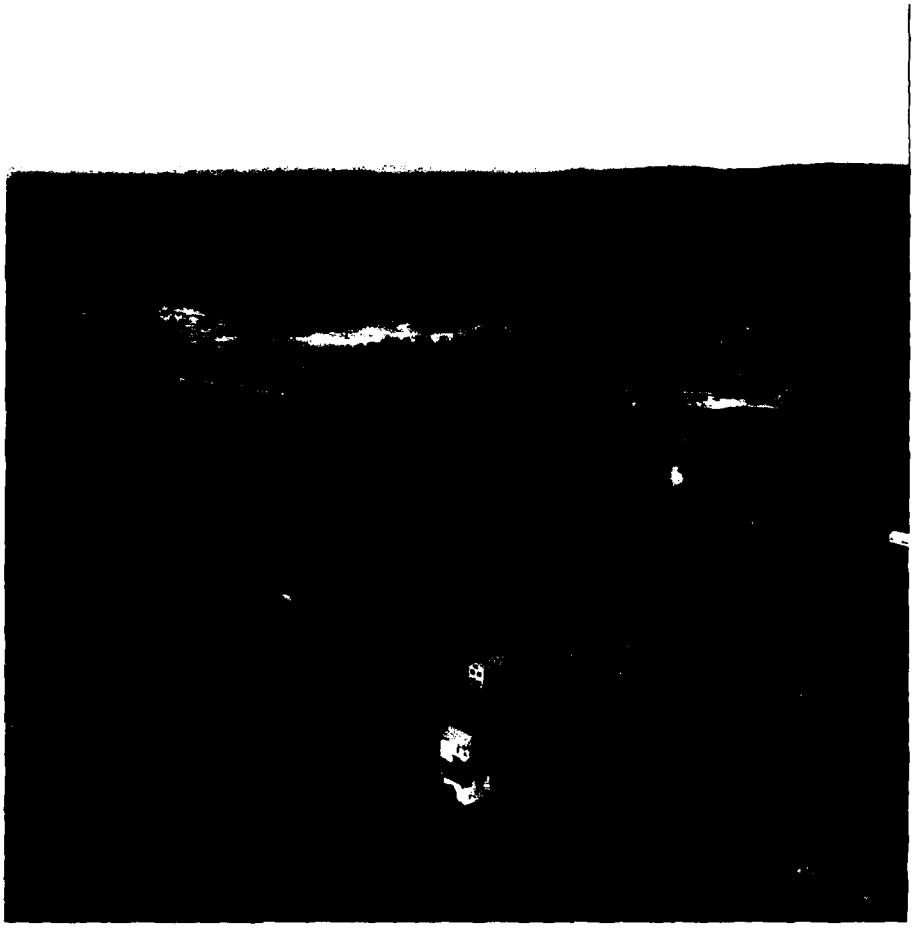
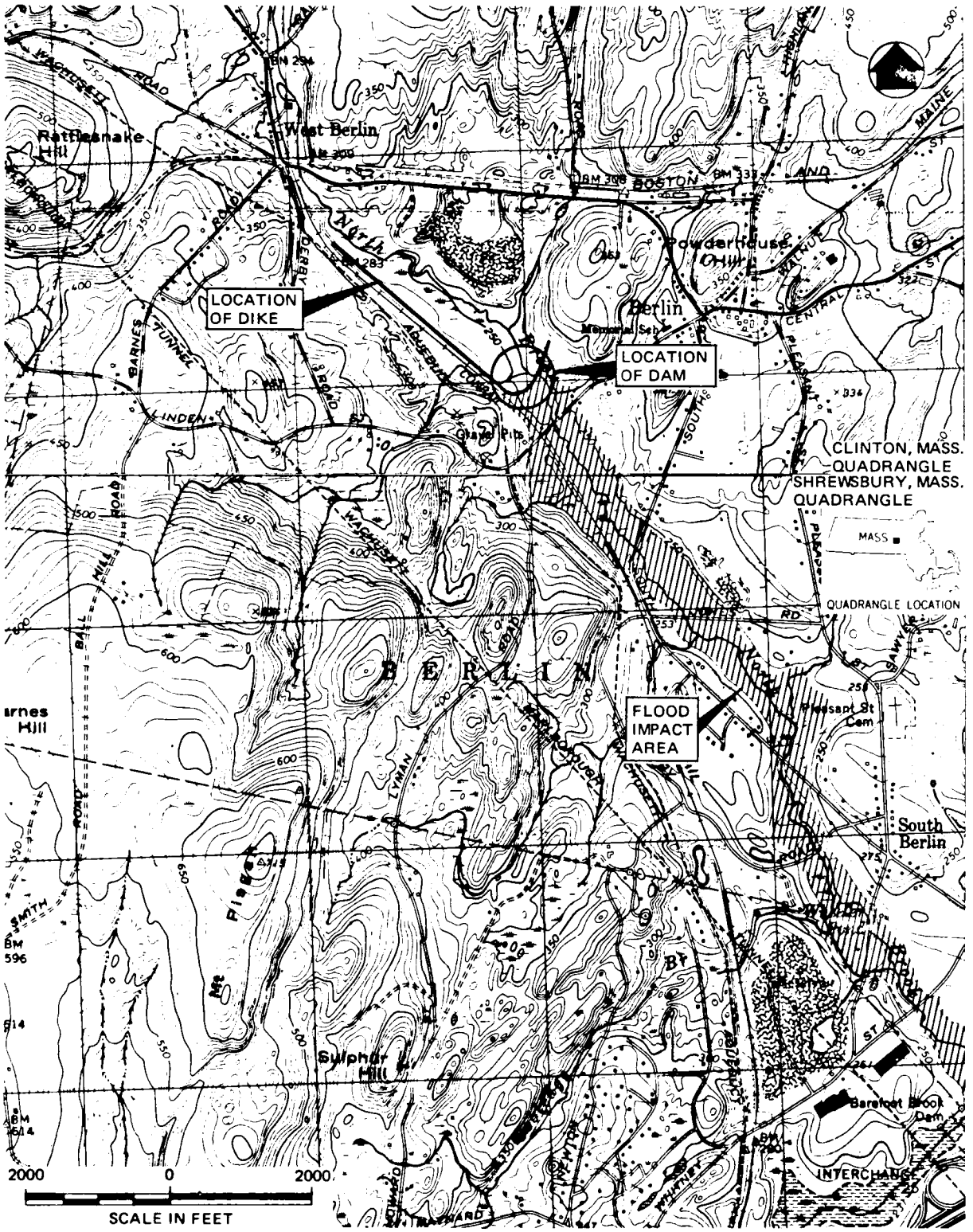
OVERVIEW
LESTER G. ROSS DAM
BERLIN, MASSACHUSETTS





LOCATION MAP - LESTER G. ROSS DAM

SECTION 4

OPERATING AND MAINTENANCE PROCEDURES

4.1 Operating Procedures

a. General. There are no regular operating procedures for this dam. Personnel from the Soil Conservation Services (SCS) and Massachusetts Water Resources Commission (MWRC) reportedly visit the dam once a year to inspect the dam and appurtenances and recommend repairs as necessary.

The flow from the reservoir into North Brook can be controlled by the stoplogs on the main spillway. These can be operated by the State at the request of the Town.

b. Warning System. There is no warning system in effect at this dam.

4.2 Maintenance Procedures

a. General. The dam is generally well maintained. The MWRC is responsible for maintenance of the facility. Periodic inspections by the MWRC and the SCS have been conducted in the past. Typical maintenance procedures have included repairing cracked concrete on the riser and impact basins, backfilling eroded areas on the dam, clearing vegetation from the slopes and discharge channel, and clearing debris from the spillway channels.

b. Operating Facilities. There has been periodic maintenance of the operating facilities at the dam. In 1976, six stoplogs on the main spillway intake were broken loose and had to be replaced. The operating condition of the stoplogs is checked annually by the Massachusetts Water Resources Commission.

4.3 Evaluation. There is a program for maintaining the embankment and appurtenant structures in good operating condition. Technical inspections are conducted on an annual basis, but there is no plan for surveillance of the embankment during and after periods of heavy rainfall, and no emergency warning system in effect. This is undesirable, considering that the dam is in the high hazard category. These programs should be implemented, as recommended in Section 7.3.

e. Downstream Channel. The main spillway and outlet discharge into the impact basin and then into the North Brook channel (see Photo No. 9). The brook flows along the edge of a disposal area for excess borrow material. The earth slopes which form the sides of the trapezoidal stream channel are slightly eroded. A minor amount of vegetation is growing on the banks, but the floor of the channel is clear of rocks and debris.

About 750 feet downstream of the dam, the Linden Street Bridge restricts the flow in the North Brook channel. Water flows under Linden Street in a 29-foot-wide by 8.4-foot-high culvert.

3.2 Evaluation. The visual inspection indicates that the dam is in good condition. However, the crown vetch growing on the embankment prevents a complete inspection of the downstream face. The stated deficiencies which must be corrected to assure the continued performance of this dam and measures to improve these conditions are outlined in Section 7.

spection, the stoplogs were submerged, and water was discharging over the weirs, preventing a closer examination of these areas. As shown on Photo No. 6, there is no footbridge or access from the shore to the spillway and stoplogs. In addition, the stop log retainer, (see Figure B-10) is bolted and cannot be easily removed.

The concrete on the inlet and riser is in good condition. There are some minor chips which are generally due to vandalism. Two large pieces of riprap had been dropped into the structure. One was caught in a slot in the left wall of the riser. The other was lodged in the entrance to the discharge conduit. The conduit was also chipped. There was no other debris visible in the main spillway structure.

The concrete impact basin at the downstream end of the dam is in good condition, with only minor chips in the concrete, most of which had already been patched. A moderate amount of flow was discharging into the basin at the time of the inspection. The outlets to the foundation drains were submerged. The basin was clear of brush and debris, however, a small obstruction consisting of riprap blocks had been built by vandals just downstream of the basin, obstructing flow in the channel.

The emergency spillway at the left abutment of the dam is in good condition. The entire spillway channel is generally kept clear of brush and debris. However, brush and numerous large pines are growing in the upstream end of the spillway. The reinforced concrete weir on the emergency spillway is anchored into bedrock and appears to be in good condition. The seepage drain underlying the emergency spillway discharges both upstream (north) into the reservoir and downstream into the North Brook. The northerly outlet of the drain was visible in the earth slope above the reservoir. The pipe was slightly rusted and no flow was visible. The outlet at the southerly end could not be located for inspection.

d. Reservoir Area. The reservoir area is sparsely developed. The Town of Berlin, Massachusetts is located approximately 2,500 feet northeast of the dam. A few residences are located on the northeast side of the reservoir, along Route 62. There is a potential for future development to occur in the reservoir area.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase I inspection of the Lester G. Ross Dam was performed on November 24, 1980. A copy of the inspection checklist is included in Appendix A. Previous inspections were conducted by the Massachusetts Water Resources Commission and the Soils Conservation Service, from 1976 to 1980. Copies of these reports are given in Appendix B. Selected photographs taken on December 5, 1980 are included in Appendix C.

b. Dam. The dam is an earthfill embankment with a main spillway/outlet structure, and an emergency spillway at the left abutment. Evidence of seepage was noted along the discharge pipe from the dike foundation drain (Station 8+18 on Figure B-4). The water was clear, and the amount of flow from this area was estimated at less than one gallon per minute. There was no flow from the discharge pipe which was about 50 percent filled with silt. The foundation drains at the toe of the dam, below the main spillway, were both submerged and flow could not be detected.

Minor erosion caused by foot traffic was noted on the downstream slope, at the transition zone between the dam and dike. There is also some evidence of automobile traffic on the top of the dam, and dirt bike trails occur in several areas both upstream and downstream of the dam and dike (see Photo Nos. 1 and 2).

No settlement or bulging was noted on the embankments, which were clear of brush and trees. An animal burrow was observed near the top of the downstream slope of the dam. The thick growth of crown vetch on the upper slope would obscure most animal burrows, and, more importantly, any signs of seepage through the embankment.

In general the rock slope protection is in good condition. However, the schistose rock which comprises part of the rock waste slope on the downstream face of the dam is severely weathered and deteriorating in one section.

c. Appurtenant Structures. The main spillway is a reinforced concrete drop inlet structure with stoplogs at the upstream intake, and lateral weirs. At the time of the

SECTION 2

ENGINEERING DATA

2.1 General. The engineering data available for this Phase I inspection includes drawings, specifications and computations dated 1967 to 1973 prepared by the U.S. Department of Agriculture, Soil Conservation Service. The data were obtained from the office of the Soil Conservation Service in Amherst, Massachusetts. Copies of previous inspection reports dated 1976 to 1980, prepared by the Massachusetts Water Resoucres Commission and the SCS are included in Appendix B.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways; the Massachusetts Department of Public Works; and the Massachusetts Water Resources Commission. In addition, we acknowledge the assistance of Mr. Chester Dodge, of the Soil Conservation Service, who provided information on the design, construction and operation of the dam.

2.2 Construction Records. A complete set of as-built drawings for the dam and appurtenances is available at the Soil Conservation Service Office in Amherst, Massachusetts.

2.3 Operating Records. No operating records are available, and there is no daily record kept of the elevation of the pool or rainfall at the dam site.

2.4 Evaluation

a. Availability. There is considerable engineering data available for this dam.

b. Adequacy. A limited review was made of the detailed hydraulic, structural and construction data. The evaluation of the adequacy of this dam is based on a brief review of this data and the available drawings, the visual inspection, past performance history and engineering judgment.

c. Validity. Comparison of the available drawings with the field survey conducted during the Phase I inspection indicates that the available information is valid. The only notable exception is the elevation of the berm on the downstream slope of the dam, shown at El. 270 on the drawings and measured at approximate El 273 in the field.

(5) Upstream channel: concrete scour apron upstream of riser, at El 244.5.

(6) Downstream channel: discharge flows through reinforced concrete conduit - 4' dia., 216 ft. long, invert El 244.5

Emergency Spillway

(1) Type: earth and rock cut channel with narrow concrete sill

(2) Length of weir: 200 feet

(3) Crest elevation: 277.5

(4) Gates: None

(5) Upstream channel: gently sloping (2 percent), unpaved to within 300 feet of weir; rock cut forms part of left sidewall

(6) Downstream channel: paved for 100 feet below weir, remainder is unpaved; 3.5 percent slope. Discharges to open field below dam.

j. Regulating Outlets

(1) Invert El: 244.5

(2) Size: 48-inch diameter

(3) Description: reinforced concrete discharge pipe, intake at main spillway, outlet in impact basin at downstream toe of dam

(4) Control mechanism: none, except stoplogs at upstream end of spillway riser.

(7) Impervious core: silt and sandy silt core to El 277.5.

(8) Cutoff: cutoff trench at varying elevations, constructed where foundation material is gravelly

(9) Grout curtain: none

Dike

(1) Type: zoned earthfill

(2) Length: 4,300 feet

(3) Height: 37

(4) Top width: 12 feet

(5) Side slopes: 2:1, upstream and downstream

(6) Zoning: earthfill with upstream zone of silty sand, downstream zone of gravel

(7) Impervious core: silt and sandy silt core to El 277.5

(8) Cutoff: cutoff trench at varying locations, constructed where foundation material is gravelly

(9) Grout curtain: none

h. Diversion and Regulating Tunnel: N/A

i. Spillway

Main Spillway

(1) Type: drop inlet

(2) Length of weir: 22 feet (combined length, both sides of riser).

(3) Crest elevation: 251.0

(4) Gates: sloplogs on intake at upstream end of riser. Top of stoplogs: 251.0; bottom of stoplogs: 245.2

(3) Spillway crest pool: main: 2,100
emergency: 4,500

(4) Top of dam: 6,500

(5) Test flood pool: 5,700

e. Storage (acre-feet)

(1) Normal Pool: 28

(2) Flood control pool: 1,934

(3) Spillway crest pool: main: 28
emergency: 1934

(4) Top of dam: 3,400

(5) Test flood pool: 2,750

f. Reservoir surface (acres)

(1) Normal pool: 10

(2) Flood-control pool: 131

(3) Spillway crest: main: 10
emergency: 131

(4) Test flood pool: 160

(5) Top of dam: 178

g. Dam

(1) Type: zoned earthfill

(2) Length: 1,200 feet

(3) Height: 44 feet

(4) Top width: 14 feet

(5) Side slopes: upstream - 3:1; downstream 2:1 to berm, then 3:1.

(6) Zoning: earthfill with upstream zone of silty sand, downstream zone of gravel with foundation drain at toe.

(4) Ungated spillway capacity at test flood elevation:
Main: 380 cfs at El 283.4
Emergency: 8,720 cfs at El 283.4

(5) Gated spillway capacity at normal pool elevation:
N/A

(6) Gated spillway capacity at test flood elevation:
N/A

(7) Total spillway capacity at test flood elevation:
9,100 cfs at El 283.4

(8) Total project discharge at top of dam: 17,000 cfs at El 286.4

(9) Total project discharge at test flood elevation:
9,100 cfs at El 283.4

c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A benchmark was established at El 255 at the top of the concrete riser on the main spillway. This elevation was taken from the record drawings.

(1) Streambed at toe of dam: 242.3

(2) Bottom of cutoff: variable

(3) Maximum tailwater (during inspection): 245

(4) Normal pool: 251

(5) Full flood control pool: 277.8

(6) Spillway crest (ungated): 251 on main spillway
277.8 on emergency spillway

(7) Design surcharge (Original design): 278.6

(8) Top of dam: 286.6

(9) Test flood surcharge: 283.4

d. Reservoir (Length in feet)

(1) Normal pool: 2,100

(2) Flood control pool: 4,500

Previous inspection reports indicate that since construction the dam has been in good condition. Repairs have been made such as replacing stop logs, and repairing chipped concrete on the impact basin.

i. Normal Operating Procedures. Personnel from the Massachusetts Water Resources Commission and the Soil Conservation Service reportedly visit the dam once a year. At that time, they review the condition of the dam and appurtenances and make recommendations for the maintenance program. The stoplogs are operated periodically at the request of the Town of Berlin in order to maintain flow in North Brook.

1.3 Pertinent Data

a. Drainage Area. The drainage area is approximately 5,952 acres (9.3 square miles) and consists of gently rolling to hilly land (see Figure D-1 in Appendix). The drainage area includes North Brook and several smaller, unnamed streams that are tributary to North Brook. About 5 percent of the drainage area is ponds and swamps. In general, the undeveloped portions of the drainage area consists mostly of woodland. Light residential development occurs along Linden Street and Lancaster Road in Berlin, and along Route 62 in Clinton. The Wachusett-Marlborough Tunnel, and the Wachusett Aqueduct both cross the drainage area southwest of the dam.

b. Discharge. Discharge from Lester G. Ross Dam flows over the stoplogs and weirs of the main spillway and through a concrete conduit to the impact basin on the downstream side of the dam. The discharge channel (North brook) is an unlined, natural channel that flows under Linden Street and eventually to the Assabet River, about 3 miles downstream.

(1) Outlet: Size - 48-inch diameter
Invert El. - 244.5.
Discharge Capacity - 126 cfs at El 251.0.

(2) Maximum known flood at damsite: N/A

(3) Ungated spillway capacity at top of dam:
Main: 390 cfs at El 286.4
Emergency: 16,610 at 286.4

slope above the channel. The drain consists of a 6-inch diameter, perforated bituminous fiber pipe. The pipe slopes in both directions from the sill, and discharges both upstream into the reservoir, and downstream near North Brook.

c. Size classification. For a dam to be classified as intermediate it must have a height between 40 and 100 feet or a maximum storage capacity between 1,000 and 50,000 acre-feet. Lester G. Ross Dam has been classified as "intermediate" on the basis of its height of 44 feet and its storage capacity to the top of the dam of 1991 acre-feet.

d. Hazard Classification. There is a house located in the flood plain for North Brook, about 700 feet downstream of the dam (see Flood Impact Area shown on the Location Map). The foundation bottom of this structure is approximately 20 feet above the floor of the stream. An assumed failure of the dam would result in a flood wave 20 feet high 750 feet downstream of the dam as compared to a flow of 14.5 feet deep prior to failure. Due to the large capacity of the reservoir, the flood wave could extend for several miles downstream. A railroad on the west side of the flood plain, and a utility building, as well as agricultural land and several major roadways will be impacted by the flood wave. More than a few lives could be lost and an appreciable amount of property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.

e. Ownership. The dam is owned by the Massachusetts Water Resources Commission, 100 Cambridge Street, Boston, Massachusetts 02114. Mr. Michael Beshara (telephone 617-727-3267) granted permission to enter the property and inspect the dam.

f. Operator. The dam is operated by personnel from Massachusetts Water Resources Commission.

g. Purpose of the Dam. The dam was constructed for flood control and is one of several dams built for this purpose as part of the SuAsCO (Sudbury-Assabet-Concord) watershed project.

h. Design and construction. Construction of Lester G. Ross Dam was completed in 1974. Drawings and specifications dated 1971 and prepared by the U.S. Department of Agriculture, Soil Conservation Service are available. The design drawings were updated in 1974 to show the dam constructed essentially as it appears today.

The intake is 3 feet wide and is controlled by stoplogs which can be adjusted to permit flow between El 245.2 and 251.0. The parallel weirs are divided into four sections by 1-foot-thick concrete walls which form the riser. The total effective length of the weirs is 22 feet, and the crest is at El 251.0. The inlet to the intake, and the top and sides of the riser are protected with trash racks constructed of galvanzied angle irons. A steel grate across the top of the riser provides access to the stoplogs at the upstream end of the structure.

The low-level outlet is a 48-inch diameter reinforced concrete conduit. The hooded inlet to the pipe is on the downstream headwall of the intake structure (see Figure B-10). The invert of the outlet is at El 244.5. The outlet conduit extends 216 feet through the dam and is founded on a concrete mat. Six reinforced concrete anti-seep collars are located at 24- foot intervals between the upstream end of the pipe and the downstream side of the central core.

There is no control mechanism on the outlet conduit, which discharges into a concrete impact basin at the downstream toe of the dam (see Photos 7 and 8). The downstream channel is about 25 feet wide, with 2:1 side slopes, and flows through a low swampy area to Linden Street.

The emergency spillway is a grass-and rock-covered channel 1,200 feet long and 200 feet wide at the crest. As shown on Figure B-3, the spillway approach is north of the left abutment of the dam, and the weir is perpendicular to the abutment. There are no sidewalls on the emergency spillway, although the left side of the channel is partially bounded by a steep bedrock slope. The floor of the approach channel slopes at 2 percent to the weir; which is at El 277.5. The weir consists of a 2-foot-wide reinforced concrete sill anchored into bedrock. The floor of the spillway channel is paved with riprap for a distance of approximately 300 feet upstream of the weir, and 100 feet downstream. The channel below the sill slopes at 3.5 percent. The spillway discharge channel is separated from the downstream toe of the dam by a dike constructed of rock fill (see Photo No. 9). Flow from the emergency spillway would enter the wide swampy area upstream of Linden Street.

A drain pipe was installed at the left side of the emergency spillway to intercept seepage fror the rock

b. Description of Dam and Appurtenances

Lester G. Ross Dam is a combined earthfill dam and dike with a maximum height of 34 feet (see Plan of Dam and Sections, in Appendix B, and Photographs in Appendix C). The main dam is 1,200 feet long, and perpendicular to the dike, which is 4,300 feet long. The dike is a continuation of the dam embankment section.

The top of the dam is 14 feet wide, and is approximately El 286.6. The upstream face of the dam is a 3:1 (horizontal:vertical) slope covered with crown vetch. The downstream face, which is also covered with vetch, is a 2:1 slope to the berm at approximately El 273.0. Below this elevation the downstream face consists of a 3:1 slope formed by rock excavated from the emergency spillway. Available drawings show that the dam is a zoned embankment with a central core consisting of silt and sandy silt material (see Figure B-6). In general the embankment is founded on silty sand. Figure B-8 indicates that a cut-off trench was required in areas of poorly graded gravel and silty gravel. The exact location of the cut-off trench is not shown. The zoned embankment consists of silty sand upstream of the central core, and gravel on the downstream side, below El 275.0. There is a foundation drain at the toe of the dam which collects seepage and discharges it at the outlet structure.

The dam ties into the dike at the transition zone (Station 22+00 as shown on Figure B-4). The top of the dike is 12 feet wide, and at the same elevation as the dam (286.6). The upstream face is a 2:1 gravel slope. The downstream face is a continuous 2:1 slope and is also covered with gravel. The dike embankment is also zoned in the same manner as the main dam (see Figure B-6).

The dike was constructed to protect the parallel railroad embankment. A foundation drain (Figure B-9) was designed to collect and discharge seepage into a ditch between the railroad embankment and the toe of the dike. The ditch joins the North Brook downstream of the dam, at Linden Street.

A concrete intake structure serves as both the main spillway and low-level outlet (see Photo No. 6 and Figure B-7). The structure consists of a reinforced concrete drop inlet with lateral round-crested weirs and an upstream intake.

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

LESTER G. ROSS DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-80-C-0054, dated April 18, 1980, has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to quickly initiate effective dam safety programs for non-Federal dams.

(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located on North Brook in the Town of Berlin, Worcester County, Massachusetts and in the Merrimack River Basin (see Location Map). The coordinates of this location are Latitude 42 deg. 22.7 min. north and Longitude 71 deg. 38.9 min. west. North Brook joins the Assabet River about 3 miles downstream of the dam.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General. Lester G. Ross Dam has a drainage area of 9.3 square miles of which 5.3 percent is ponds and swamps (see Figure D-1, Drainage Area Map). The land is gently rolling to hilly, and sparsely developed.

There are no dams upstream of Lester Ross Dam to provide additional storage within the watershed.

The surface area of the normal pool is approximately 10 acres, and the maximum storage capacity of the dam is 3,400 acre-feet at El 286.6.

The low-level outlet can discharge a flow of 126 cfs when the reservoir is at El 251 which is the crest of the main spillway. At this reservoir elevation and with no additional inflow, the outlet can lower the reservoir by 1 foot in about 1-1/2 hours.

5.2 Design Data. Hydraulic computations are available at the Soil Conservation Service office in Amherst, Massachusetts. The calculations indicate that the dam was designed to impound a "100-year frequenty storm of 9.7 inches of rain in 6 hours, without discharge occurring in the emergency spillway. The inflow used for this storm was 5,663 cfs. The design elevation of the crest of the emergency spillway was 277.5, as compared to an as-built elevation of 277.8. The top of the dam was designed and constructed at El 286.6.

5.3 Experience Data. There is no record that the emergency spillway was ever overtopped since its completion in 1974. No records of past discharge are available. The SCS representative indicated that the dam was constructed to prevent the reoccurrence of past flooding along the Assabet River.

5.4 Test Flood Analysis. Lester G. Ross Dam has been classified in the "intermediate" size and "high" hazard categories. According to the Corps of Engineers guidelines, a test flood equal to the full PMF should be used to evaluate the capacity of the spillway.

The PMF rate for the North Brook watershed was calculated to be 1,400 cfs per square mile of drainage area. This calculation is based on the average slope of 1.6 percent in the drainage area, the pond-plus-swamp area to drainage area ratio of 5.3 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). For this analysis, the peak flow rate was determined to be between the guide curves for "flat and coastal" and "rolling" topography.

Applying the full PMF rate to the 9.3 square mile drainage area results in a peak test flood inflow of 13,000 cfs. By adjusting the test flood inflow for surcharge storage, the peak test flood outflow was calculated to be 9,100 cfs (978 cfs per square mile), with the reservoir level at El 283.4.

Hydraulic analyses indicate that the main spillway can discharge 390 cfs and the emergency spillway can discharge 16,610 cfs with the reservoir at El 286.6 which is the low point on top of the dam. The spillways combined can discharge 187 percent of the full PMF without overtopping the dam.

5.5 Dam Failure Analysis. The peak discharge rate due to failure of the dam was calculated to be 41,200 cfs with the pond at El 283.4. This calculation is based on a maximum head of 29.2 feet and an assumed 121-foot wide breach occurring in the main dam.

There is one house located along the stream channel 700 feet downstream of the dam. The foundation of this structure is approximately 20 feet above the bottom of the stream. Due to the configuration of the channel, some attenuation of the flood flow is expected. An assumed failure of the dam could result in a flood wave of 20 feet as compared to a depth of flow of 14.5 feet deep prior to failure. The flood wave would damage the house and a nearby utility building, and would overtop Linden Street and the railroad tracks. Due to the large capacity of the reservoir, the failure flood wave could extend for several miles downstream. Agricultural land, as well as several major roadways would be impacted, resulting in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dam has been placed in the "high" hazard category.

SECTION 6

STRUCTURAL STABILITY

6.1 Visual Observations. The evaluation of the structural stability of Lester G. Ross Dam is based on a review of previous inspection reports and available drawings, and the visual inspection conducted on November 24, 1980. As discussed in Section 3, Visual Inspection, the dam is in good condition. Seepage was observed along the discharge pipe at the foundation drain at the dike. Minor erosion due to foot traffic was noted on the downstream slope near the transition zone between the dam and dike. An animal burrow was observed near the top of the downstream slope of the dam. Otherwise, only minor erosion and ruts due to vehicular traffic were noted on the top and abutments of the dam. There are no trees or brush growing on the dam.

6.2 Design and Construction Data. Construction of Lester G. Ross Dam was completed in 1974. Computations for design of the dam and spillways are available at the Soil Conservation Service.

Drawings dated 1971 and updated in 1974 show the as-built construction of the dam (see Figures B-3 through B-10). The drawings show that the dam is a zoned earthfill embankment founded on sandy silt.

Detailed subsurface information, including test boring data and geologic cross sections are available. At that time soil samples were taken from test pits and test borings for grain size analyses and permeability tests.

Figure B-6 shows a typical dam section with details of the zoning in the embankment. The earthfill for the three zones was obtained from on-site borrow areas. A discontinuous cutoff trench extends to variable depths below the base of the dam, as indicated on Figure B-8. The side slopes of the embankment are 3:1 upstream and 2:1 downstream, to El 273.0. A 3:1 rockfill slope was added to the downstream face of the dam below elevation 273.0.

6.3 Post Construction Changes. There have been no post construction changes made to the dam, which was completed in 1974.

6.4 Seismic Stability. The dam is located in Seismic Zone No. 2, and in accordance with Corps of Engineers' guidelines does not warrant further seismic analysis at this time.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. As a result of the visual inspection, the review of available data, and information on operation and maintenance, the dam is considered to be in good condition. The following deficiencies must be corrected to assure the continued performance of this dam: seepage along the discharge pipe of the foundation drain at the dike; silt accumulation in the discharge pipe; minor erosion on the downstream slope of the dam, near the right abutment; animal burrow on the downstream slope of the dam, and boulders lodged in the main spillway and in the channel downstream of the impact basin.

b. Adequacy. The evaluation of this dam is based on a review of the available data, the visual inspection, past performance and engineering judgment.

c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within 2 years after receipt of this Phase I Inspection Report.

7.2 Recommendations.

It is recommended that the Owner employ a qualified registered engineer to evaluate the need for cleanouts for the foundation drains and the seepage occurring in the vicinity of the foundation drain discharge pipe.

The Owner should implement the recommendations of the Engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:

(1) Fill in, add topsoil and seed eroded areas on the downstream face of the earth embankment portions of the dam to prevent continued erosion. Also, backfill the animal burrow located on the upper slope.

(2) Repair all chipped concrete on the main spillway and impact basin.

(3) Remove all brush from the floor of the emergency spillway approach channel.

(4) Remove boulders lodged in the main spillway.

(5) Remove boulders from the downstream end of the impact basin.

(6) Institute a definite plan for surveillance of the dam and spillway during and after periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dam.

(7) Continue the program of maintenance inspections. The maintenance program should be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris caught on the spillway weir and discharge pipe.

(8) Continue the program of technical inspections of this dam on an annual basis. The downstream slope should also be inspected during periods of high water level for the occurrence of seepage or soft spots.

7.4 Alternatives. There are no practical alternatives to the above recommendations.

APPENDIX A

PERIODIC INSPECTION CHECKLIST

LESTER G. ROSS DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Lester G. Ross Dam

DATE November 24, 1980

TIME 8:30 a. m.

WEATHER Rainy, 40's

W.S. ELEV. 251.7 U.S. 245 DN.S.

PARTY:

1. E. Greco - M & E - Geotechnical
2. L. Branagan - M & E - Hydraulics
3. S. Pierce - M & E - Geotechnical
4. S. Nagel - M & E - Geotechnical
5. F. Gordon - M & E - Geotechnical
6. F. Sviokla - M & E - Geotechnical
7. C. Dodge - Soil Conservation Service
8. K. McGuire - Massachusetts Water Resources Commission
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	Greco/Pierce	
2.	Dike	Greco/Pierce	
3.	Principal Spillway	Branagan/Greco/Pierce	
4.	Emergency Spillway	Branagan/Greco/Pierce	
5.			
6.			

PERIODIC INSPECTION CHECK LIST

PROJECT Lester G. Ross Dam DATE November 24, 1980

PROJECT FEATURE Dam - approx. Sta. 10 + 00 to 22 + 00. NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

Note: u/s = upstream slope, d/s = downstream slope

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	Zoned earthfill embankment. 286.6
Current Pool Elevation	251.7
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible.
Pavement Condition	No pavement. Top is sand in good condition. Tire marks indicated limited vehicular traffic.
Movement or Settlement of Crest	None visible.
Lateral Movement	None
Vertical Alignment	Good
Horizontal Alignment	Curved at both abutments of main dam.
Condition at Abutment and at Concrete Structures	No concrete structures-left abutment ties into right embankment of emergency spillway. Right abutment ties into dike. Good condition.
Indications of Movement of Structural Items on Slopes	No structures on slopes of main dam.
Trespassing on Slopes	Animal burrow near top of d/s slope. Minor erosion by foot traffic.
Sloughing or Erosion of Slopes or Abutments	Footpath worn on d/s slope of right abutment. (at dam/dike transition).
Rock Slope Protection - Riprap Failures	u/s-riprap at toe, vetch on remaining slope-good condition. d/s-grass on upper slope, waste rock on lower slope, rock is badly weathered schist in some areas-elsewhere in good condition.
Unusual Movement or Cracking at or near Toes	None visible.
Unusual Embankment or Downstream Seepage	None visible.
Piping or Boils	None visible.
Foundation Drainage Features	See Figures in Appendix B. Foundation drain at toe of dam. Outlets to drain visible but submerged in impact basin-cannot measure flow.
Toe Drains	
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Lester G. Ross Dam DATE November 24, 1980

PROJECT FEATURE Dike Embankment Approx sta 22 + 00 to 65 + 00 NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	Zoned earthfill embankment.
Crest Elevation	286.6
Current Pool Elevation	251.7
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible.
Pavement Condition	Cobble pavement, minor tire tracks on top.
Movement or Settlement of Crest	None visible.
Lateral Movement	None
Vertical Alignment	Good
Horizontal Alignment	Straight-curves at NW end.
Condition at Abutment and at Concrete Structures	No concrete structures. Abutments appear to be in good condition.
Indications of Movement of Structural Items on Slopes	No structural items.
Trespassing on Slopes	Footpath on d/s slope at dam/dike transition.
Sloughing or Erosion of Slopes or Abutments	None visible except for footpath.
Rock Slope Protection - Riprap Failures	u/s (reservoir side) cobbles over gravel-good condition. d/s (RR side) cobbles, good condition.
Unusual Movement or Cracking at or near Toes	None visible.
Unusual Embankment or Downstream Seepage	Toe drain along d/s slope discharges into ditch at toe-seepage noted adjacent to outlet of pipe-est. 2-3 gpm.
Piping or Boils	None visible.
Foundation Drainage Features	Toe drain on d/s slope of dike-discharges into ditch near Sta 21 + 00 on dam. 10" ϕ discharge.
Toe Drains	Pipe visible-half silted up flow beside pipe instead of through pipe.
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Lester G. Ross Dam DATE November 24, 1980

PROJECT FEATURE Principal Spillway NAME L. Branagan

DISCIPLINE Geotechnical/Hydraulics NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE a. Approach Channel	Concrete drop inlet structure. (See drawings in Appendix B) Concrete scour apron upstream of riser. No approach channel.
Slope Conditions	Submerged
Bottom Conditions	--
Rock Slides or Falls	--
Log Boom	Steel trash rack in upper and lower stages of riser-good condition.
Debris	One boulder caught in slot in left wall of riser. One boulder caught in entrance to outlet conduit.
Condition of Concrete Lining	--
Drains or Weep Holes	--
b. Intake Structure	
Condition of Concrete	Good condition; slight staining below waterline, minor chips, probably due to vandalism.
Stop Logs and Slots	Submerged - 20 wooden stoplogs installed at u/s end of inlet structure.
c. Transition and Conduit	Hooded inlet to conduit chipped by riprap boulder thrown into structure. 4' ϕ conduit not visible except at discharge end.

PERIODIC INSPECTION CHECK LIST

PROJECT Lester G. Ross Dam DATE November 24, 1980

PROJECT FEATURE Principal Spillway at Outlet NAME L. Branagan

DISCIPLINE Geotechnical/Hydraulic NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	RC impact basin at discharge end of principal spillway. Good condition.
General Condition of Concrete	
Rust or Staining	Minor-at and below water line.
Spalling	None
Erosion or Cavitation	Chipped by vandalism-boulders thrown into structure.
Visible Reinforcing	None visible.
Any Seepage or Efflorescence	None visible.
Condition at Joints	Good
Drain Holes	Weep holes at base of sidewalls (submerged). Also discharge ends of foundation drain.
Channel	Unlined channel beyond concrete impact basin.
Loose Rock or Trees Overhanging Channel	Some brush, no trees or rocks.
Condition of Discharge Channel	Fair-small "dam" has been constructed across channel, using riprap blocks. This should be removed.
	Channel flows through disposal area to North Brook Channel under Linden Street Bridge.

PERIODIC INSPECTION CHECK LIST

PROJECT Lester G. Ross Dam DATE November 24, 1980

PROJECT FEATURE Emergency Spillway NAME S. Pierce

DISCIPLINE Geotechnical/Hydraulic NAME L. Branagan

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Emergency spillway approximately 1100 ft. long, 200 ft. wide. Narrow concrete weir across spillway channel. No structures or training walls at approach.
a. Approach Channel	
General Condition	Fair-approach to spillway is narrower than the rest of the channel
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Brush and several large pines growing in entrance to channel. Mostly grass floor, 400' riprap sectio near weir.
b. Weir and Training Walls	
General Condition of Concrete	No walls-left bank is rock cliff. Earth embankment & rock waste dike adjacent to left abutment of dam. RC weir anchored to bedrock, in good condition.
Rust or Staining	None visible.
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None visible.
Drain Holes	Spillway drain at toe of bedrock cliff. Drains into reservior at NW end, through 6" C. M. pipe (slightly rusted, no flow)
c. Discharge Channel	
General Condition	Good, dirt bike trail crosses channel and goes up right embankment and dam.
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Riprap for approx. 100' d/s of weir, then grass.
Other Obstructions	None

APPENDIX B

PLANS OF DAM AND PREVIOUS INSPECTION REPORTS

AS-TRIAL
22/76

OPERATION AND MAINTENANCE
INSPECTION RECORD

U.S. Dept. of Agriculture
Soil Conservation Service

Project LESTER G ROSS Inspection Date 8/30/78

Site Name/No. SUASCO Type MULTIPLE PURPOSE

Type of Inspection: Special ☐ Annual ☒ Structure Operation: Satisfactory ☒ Unsatisfactory ☐

Sponsoring Local Organization: DIVISION OF WATER RESOURCES

Present for Inspection: DAN CULBURN DEM, DICK DARBY, MIDDLESEX DISTRICT, ERNIE STRUZZIERO, WRC, GAY FOLLEY, CECIL CURRIN, HARRY BOUTIETTE SCS

ITEM	Condition * S or U	Maintenance & Needed Repairs	Estimated Costs	Agreed Date Repairs to be Complete
1. Vegetation	U	FERTILIZE DAM SIDE SLOPES W/BORON AS AN ADMIXTURE (400 LBS/ACRE)	2000 -	JUNE 1979
2. Fences				
3. Principal Spillway	U	CLEAN FRONT & SIDES OF RISER FROM DEBRIS. REMOVE ROCK FROM IMPACT CASIN (2ea)	300 - 200	JUNE 1979
4. Emergency Spillway	U	REMOVE SMALL TREES & BRUSH FROM INLET END OF E.S.	300 -	JUNE 1979
5. Embankment & Riprap	U	REMOVE SMALL TREES FROM D/S SLOPE & FROM DAM SIDE SLOPES.	1500 -	JUNE 1979
6. Reservoir Area				
7. Gates or Valves				
8. Outlet Channels	U	REMOVE GROWTH IN CHANNEL @ IMPACT BASIN.	200 -	JUNE 1979
9. Structure Drainage Outlets	U	CUT & REMOVE GROWTH FROM TILE OUTLET @ E.S. OUTLET.	100 -	JUNE 1979
10. ~~Access Rd~~ BORROW AREA 1	U	MANY RILLS DUE TO RUN OFF PLANS ARE PRESENTLY BEING PREPARED TO REGRADE AREA		
11. BORROW AREA 2	U	FILL IN SINK HOLES AT UPPER END	300 -	JUNE 1979

REMARKS: (over) S = Satisfactory; U = Unsatisfactory

LANDOWNER ADJACENT TO E.S. #1 HAS CREATED A TRAIL THROUGH THE E.S. FLOOR. AN ATTEMPT SHOULD BE MADE TO ENCOURAGE USE OF A NEW ROUTE BYPASSING THE E.S.

(District Conservationist) (Project Engineer) (SLO Representative)

(Report due annually: July 1)

Su As Co Watersheds - continued

3. Remove debris from around Riser· trees and logs, etc.

4. Cut and remove growth from Channel.

B) East Bolton Dam

1. Clean debris from around Riser.

2. Cut and remove three dead trees - remove brush, downstream and upstream.

C) Diversion Channel

1. Cut brush and remove growth from rock rip-rap, both ends.

D) Finn Road Culvert

1. Replace rip-rap, both sides.

E) Campbell's Dike

1. Mow grass.

Ross Site (Berlin) JULY, 1977

1. Clean up debris from Impact Basin and Riser. Cut small growth from dam slopes.

2. Repair breach in water retaining dike and smooth erosion scars downstream side of dike.

MA-AS-TRIAL
3/22/76

OPERATION AND MAINTENANCE
INSPECTION RECORD

U.S. Dept. of Agriculture
Soil Conservation Service

Project SuAsCo Inspection Date 6-7-76

Site Name/No. Ross Site Type Floodwater Retarding

Type of Inspection: Special [X] Structure Operation: Satisfactory [X]

Annual [ ] Unsatisfactory [ ]

Sponsoring Local Organization: Water Resources Commission

Present for Inspection: Eric Christenson, Cecil Curbin, Chris Hill, Tate, Harry Bouette, Gayland Folley, Tom Doucette, Emerson Chandler, SCS

ITEM	Condition * S or U	Maintenance & Needed Repairs	Estimated Costs	Agreed Date Repairs to be Complet
1. Vegetation	U	Fertilize entire site 10-10-10 @ 8-16-16	1,500	Late Sum Early Fa
2. Fences	U	Repair fence @ old access in Borrow #1	250	Late Sum Early Fa
3. Principal Spillway	U	Repair chipped concrete @ impact basin (ie. Gunite-Dura-Gel)	150	Late Sum Early Fal
4. Emergency Spillway	S			
5. Embankment & Riprap	S			
6. Reservoir Area	S			
7. Gates or Valves	S			
8. Outlet Channels	S			
9. Structure Drainage Outlets	S			
10. Access Rd.	S			
11. Misc	U	Repair water retaining dike in Borrow Area #1	100	Late Sum Early Fa

REMARKS: over

* S = Satisfactory; U = Unsatisfactory

RECEIVED
JUN 11 1976

Gayland E. Folley (District Conservationist) | Richard M Bartlett (Project Engineer) | Thomas F Wright (SLO Representative)

(Report due annually: July 1)

LESTER G. ROSS DAM

March 29, 1976

TO: Thomas F. Doucette, Engineering

FROM: Ernie Struzziero & Kevin McGuire

SUBJECT: Inspection of various Sites

Kevin McGuire, Fletcher Pyle & Ernie Struzziero, checked on the following sites:

Ross Site: Stop planks - placed at Trash Gate total of 20 planks; previous planks (6) that were placed had been broken loose & were found in pool, replaced back in place at Trash Rack - tool planks at Trash Rack 20

Millham Dam: Checked and found that Contractor had made progress since last inspection.

Gold Harbor Brook A-4C Northboro - removed large tree branch at Trash Rack, condition good - water flowing - no stoppage.

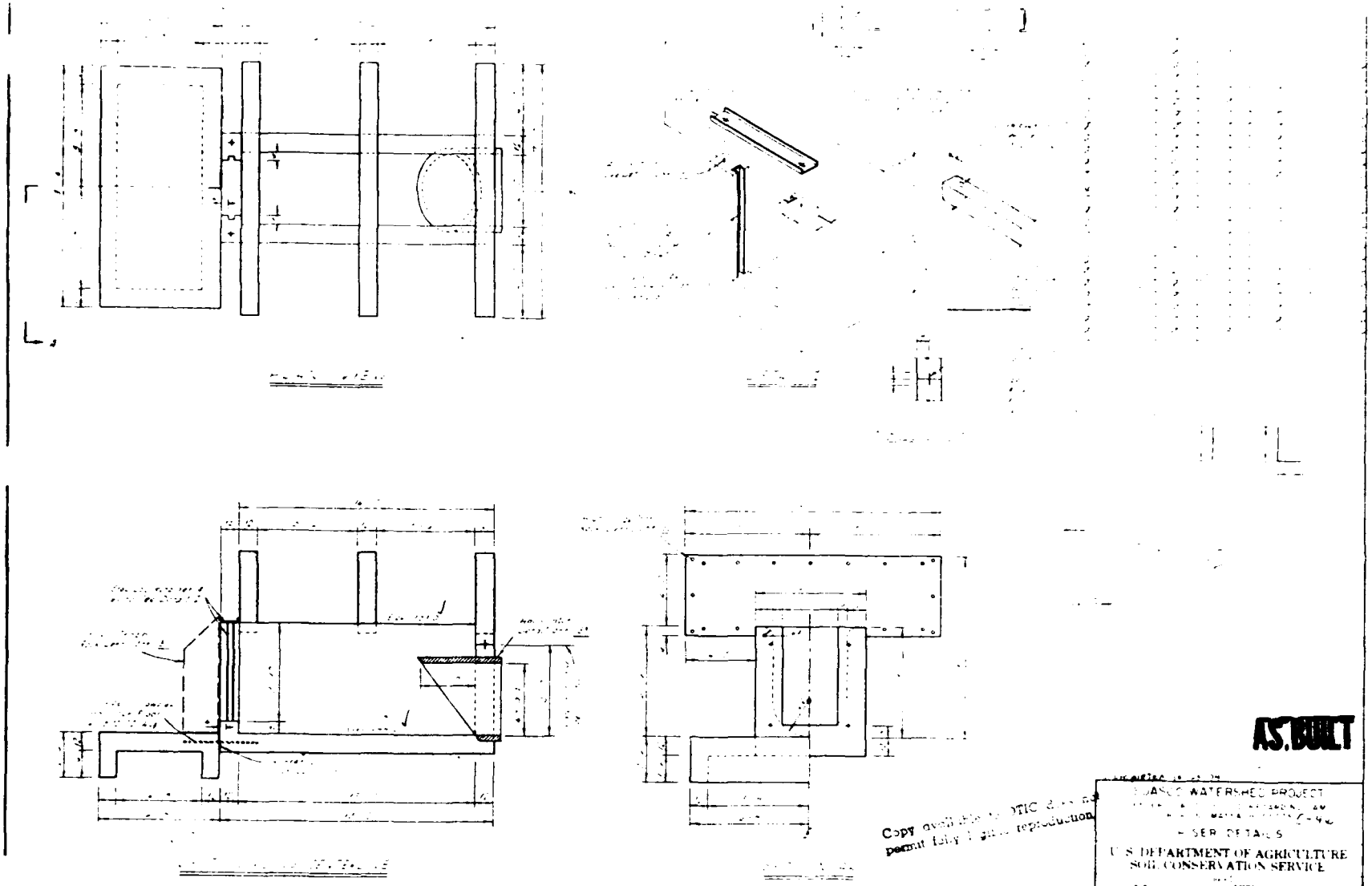
George H. Nichols (A-1) Site: Control gate closed all the ways. Removed bracket attachment that was attached to gate stem. Bracket and bolts are loose and away from concrete structure. Water no longer flowing thru spillway.

Very truly yours,

Ernie Struzziero

Ernie Struzziero,
Inspector

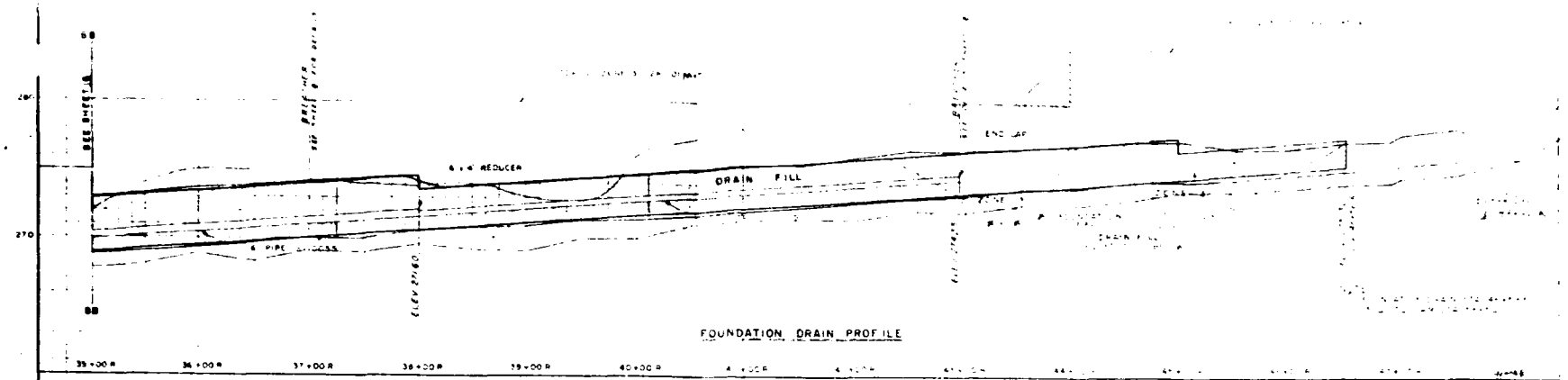
ES/hp



AS BUILT

BASCO WATERSHED PROJECT
[illegible]
USER DETAILS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FIGURE B-16

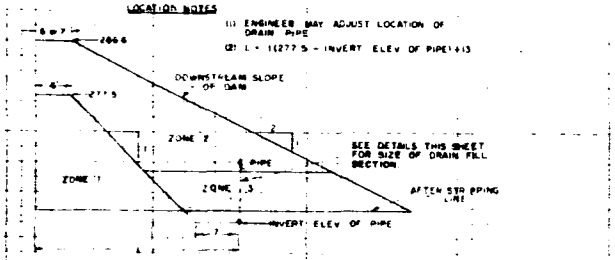


FOUNDATION DRAIN PROFILE

LOCATION NOTES

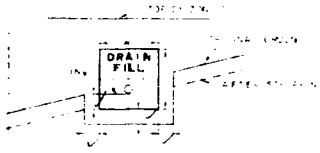
(1) ENGINEER MAY ADJUST LOCATION OF DRAIN PIPE

(2) L = (277.5 - INVERT ELEV. OF PIPE) 4:1



DETAIL OF DRAIN PIPE LOCATION

NOT TO SCALE



DETAIL OF FOUNDATION DRAIN

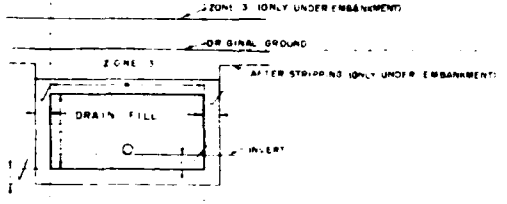
STA 10+00 R TO 43+00 R

NOT TO SCALE

DETAIL OF DRAIN TRENCH

STA 45+00 R TO EE+56 R

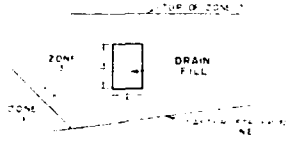
NOT TO SCALE



DETAIL OF FOUNDATION DRAIN

STA 8+18 R TO 10+00 R

NOT TO SCALE



DETAIL OF DRAIN TRENCH

STA 43+00 R TO 45+00 R

NOT TO SCALE

DIMENSIONS OF DRAIN FILL

STA	W	H
8+18 R TO 23+00 R	4	4
23+00 R TO 28+00 R	6	4
28+00 R TO 33+00 R	6	5
33+00 R TO 38+00 R	6	6
38+00 R TO 43+00 R	6	7

CONSTRUCTION DETAILS

1) RAISE THE ELEVATION OF ZONE 3, IF REQUIRED TO INSURE 2' MINIMUM COVER OVER DRAIN.

2) THE ENGINEER MAY APPROVE AN ADJUSTMENT OF THE SHAPE OF THE DRAIN FILL CROSS SECTION TO FACILITATE PLACEMENT.

COMPLETED 10-29-74 AS BUILT

SUASCO WATERSHED PROJECT
LESTER G ROSS FLOOD RETARDING DAM
BERLIN, MASSACHUSETTS

FOUNDATION DRAIN PROFILE & DETAILS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MA-311 P

FIGURE B-9

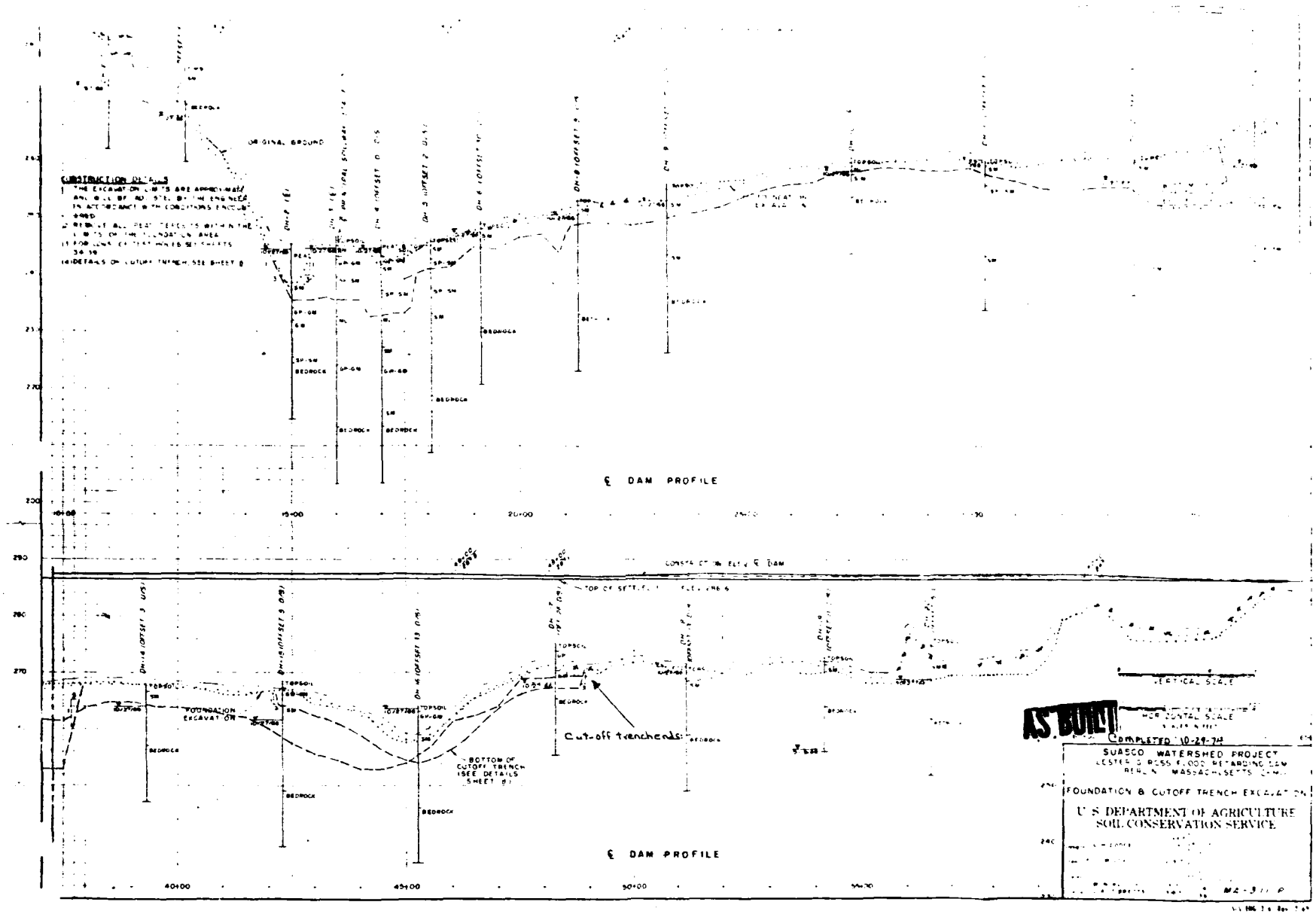

ORIGINAL GROUND
BEDROCK
TOPSOIL
SP-SM
SM
GP-GM
℄ DAM PROFILE
15+00
20+00
25+00
30
TOP OF SETTLED EMBANKMENT ELEV. ℄ DAM
FOUNDATION EXCAVATION
Cut-off trenches
BOTTOM OF CUTOFF TRENCH (SEE DETAILS SHEET 8)
40+00
45+00
50+00
55+00
VERTICAL SCALE
HORIZONTAL SCALE
AS BUILT
Completed 10-29-74
SUASCO WATERSHED PROJECT
LESTER S. ROSS FLOOD RETARDING DAM
BERLIN, MASSACHUSETTS
FOUNDATION & CUTOFF TRENCH EXCAVATION
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FIGURE B-8

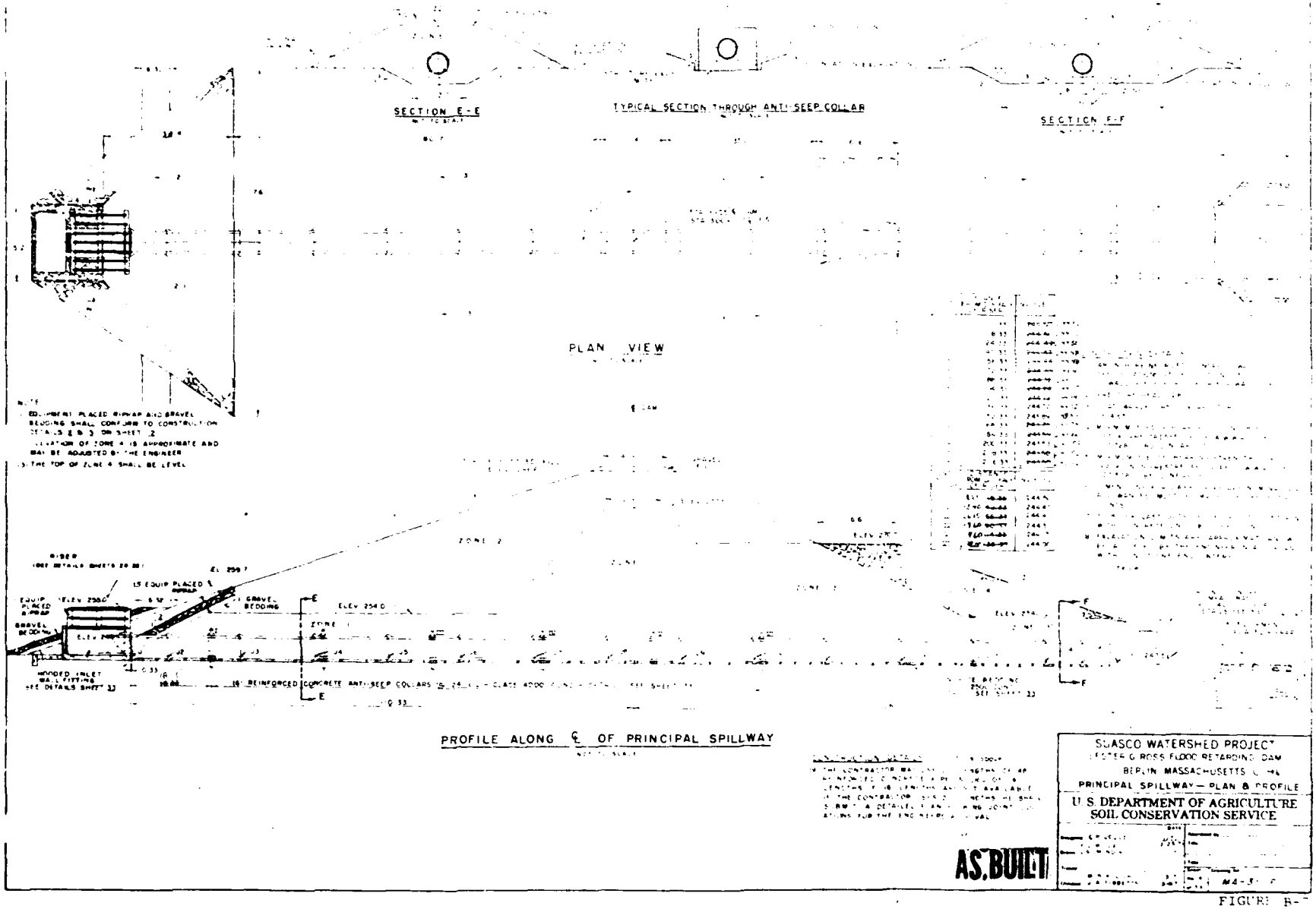
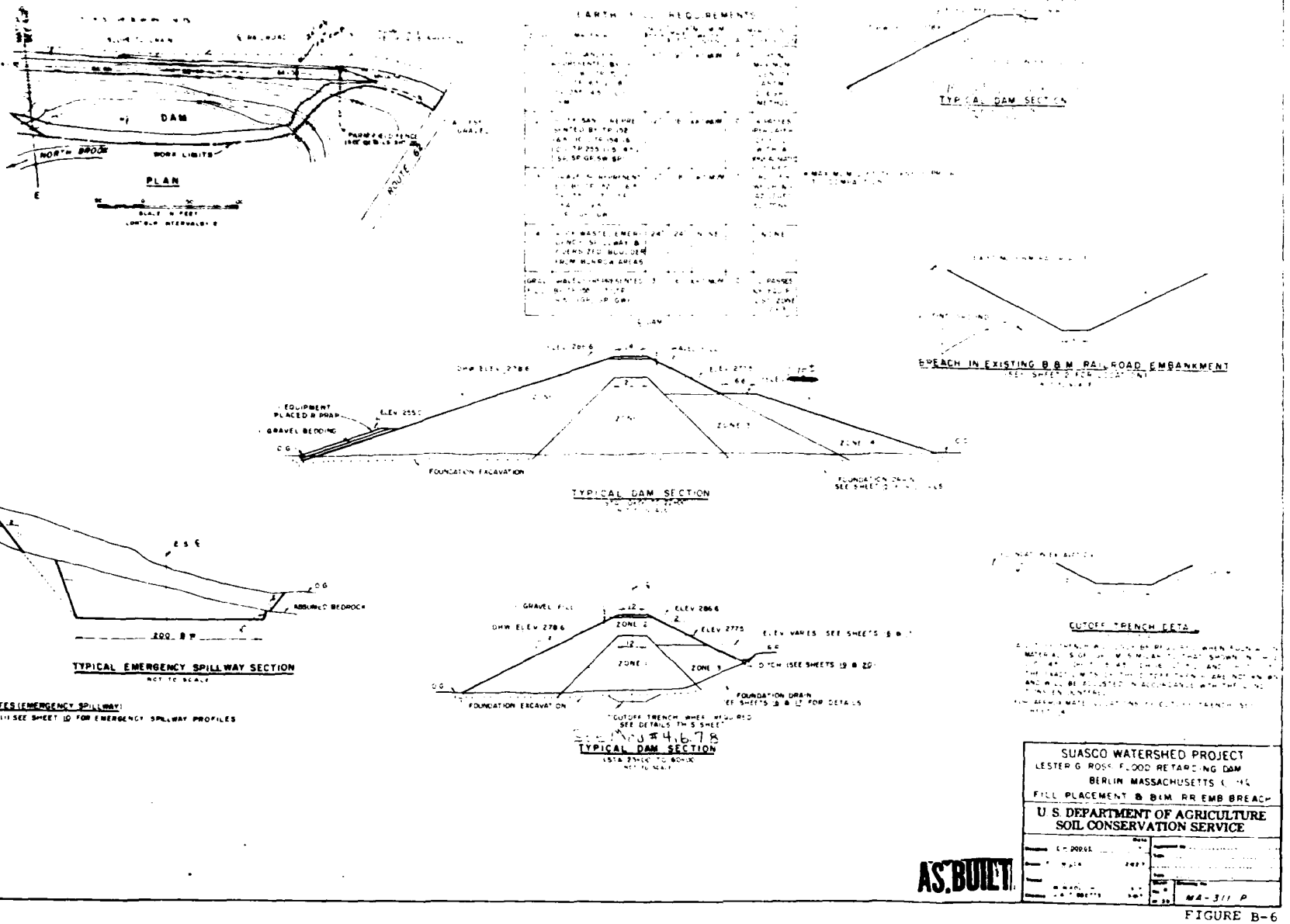


FIGURE B-7



SUASCO WATERSHED PROJECT
LESTER G ROSS FLOOD RETARDING DAM
BERLIN MASSACHUSETTS
FILL PLACEMENT & B&M RR EMB BREACH
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MA-311 P

FIGURE B-6

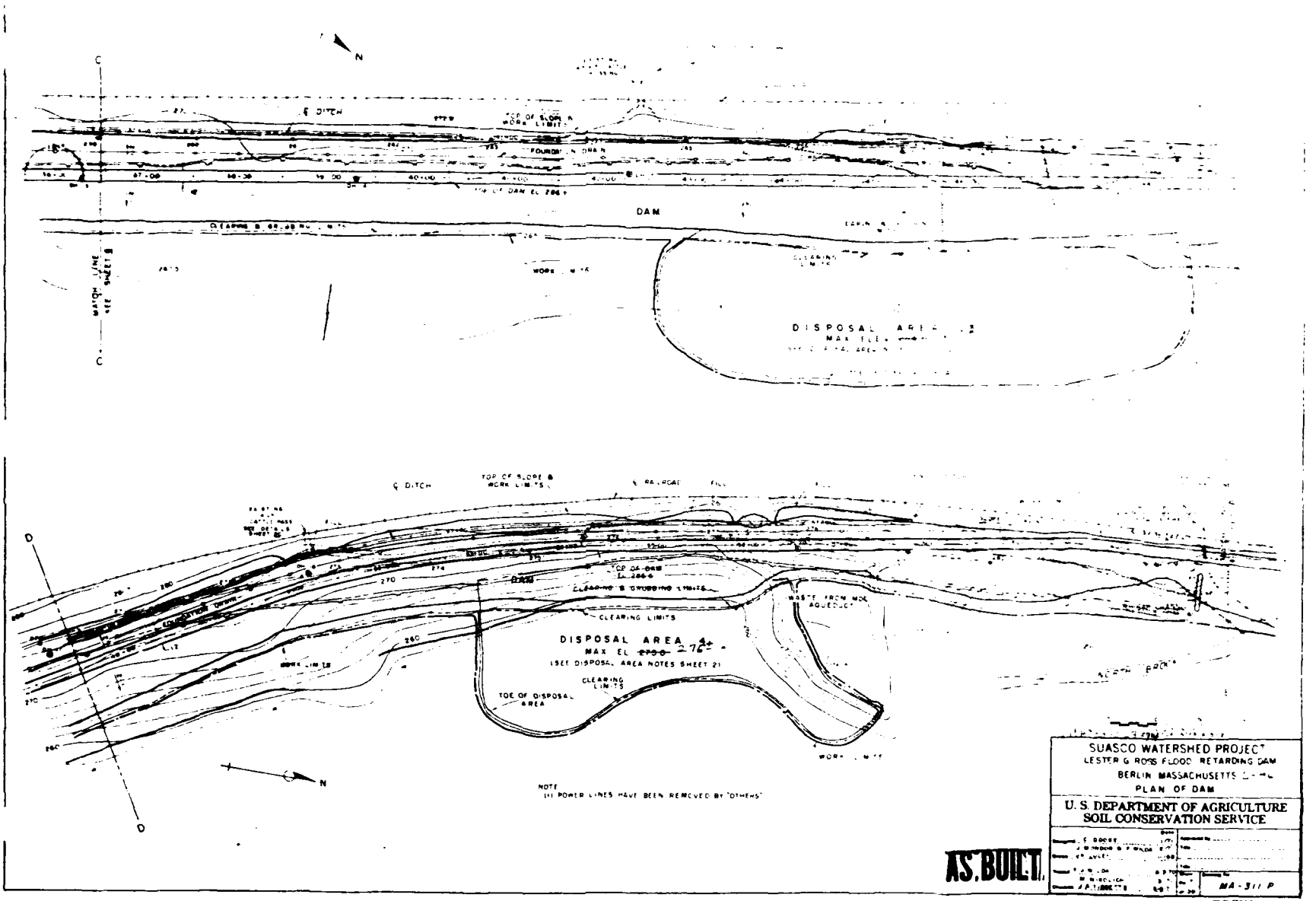
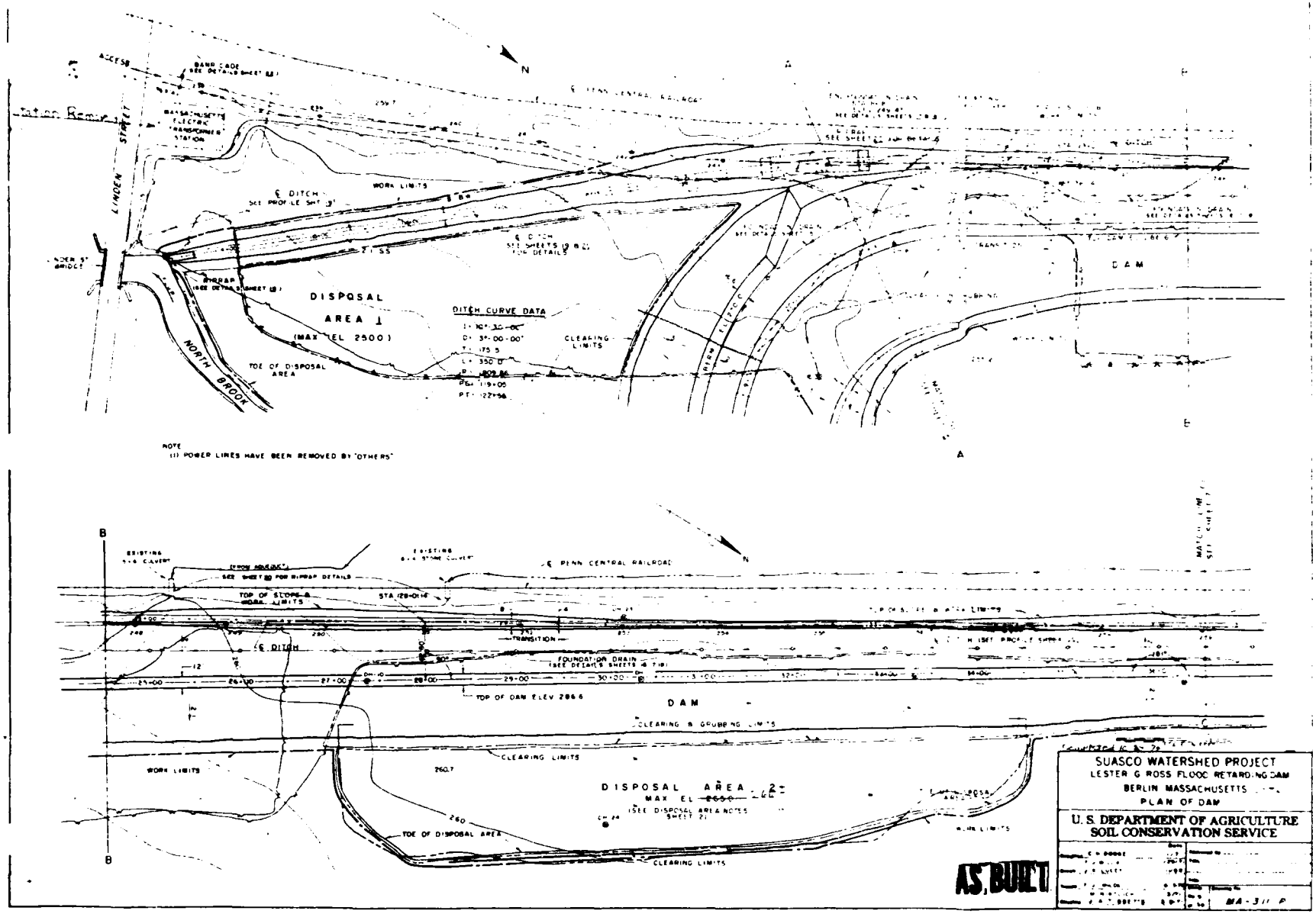

DAM
DISPOSAL AREA
MAX EL 270±
(SEE DISPOSAL AREA NOTES SHEET 2)
CLEARING LIMITS
TOE OF DISPOSAL AREA
TOP OF DAM EL 286.6
CLEARING & GRUBBING LIMITS
WASTE FROM MDC AQUEDUCT
NOTE
(1) POWER LINES HAVE BEEN REMOVED BY "OTHERS"
AS BUILT
SUASCO WATERSHED PROJECT
LESTER G ROSS FLOOD RETARDING DAM
BERLIN MASSACHUSETTS
PLAN OF DAM
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MA-311-P

FIGURE B-5



SUASCO WATERSHED PROJECT
LESTER G ROSS FLOOD RETARDING DAM
BERLIN MASSACHUSETTS
PLAN OF DAM

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MA-311-P

FIGURE B-4

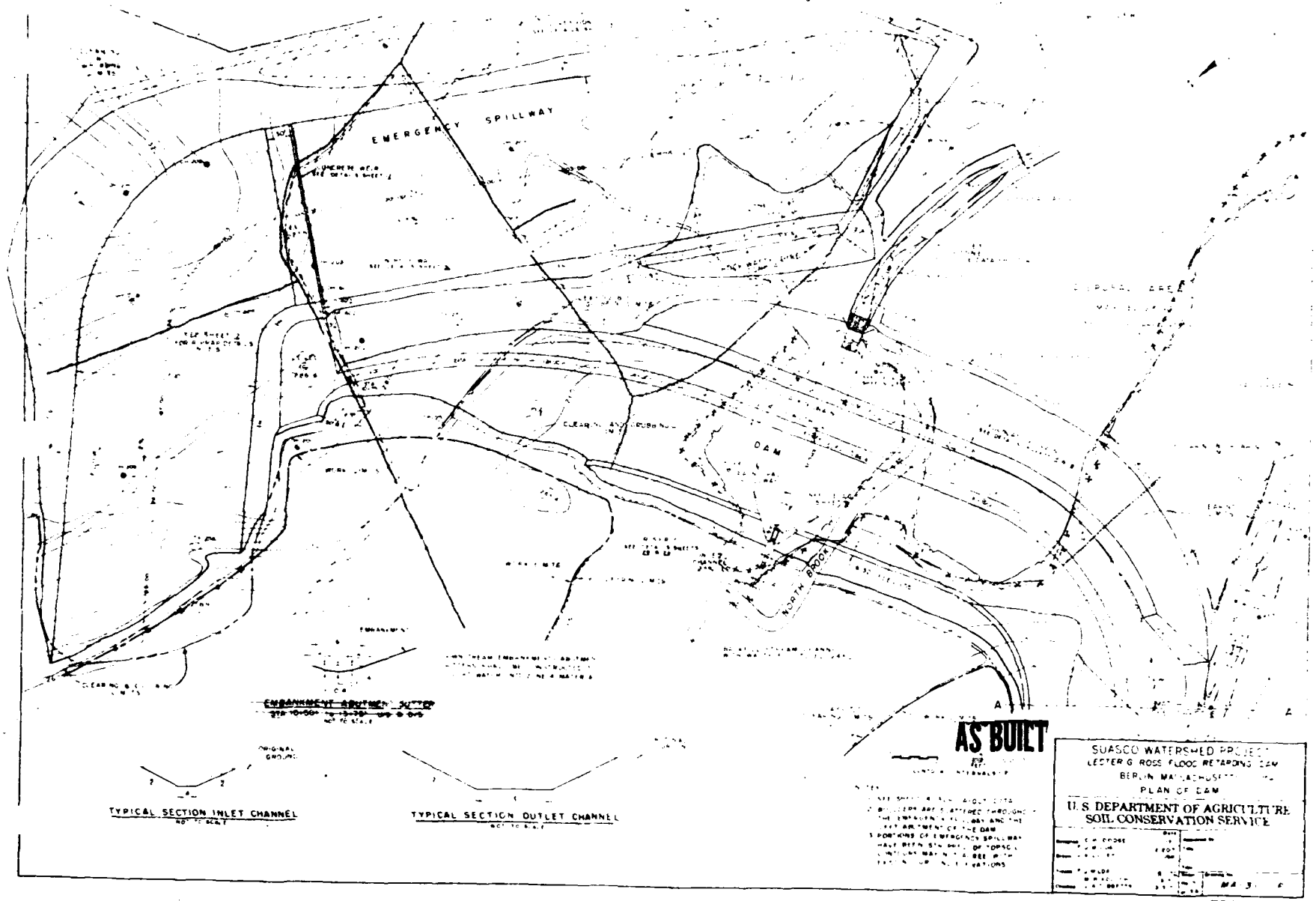
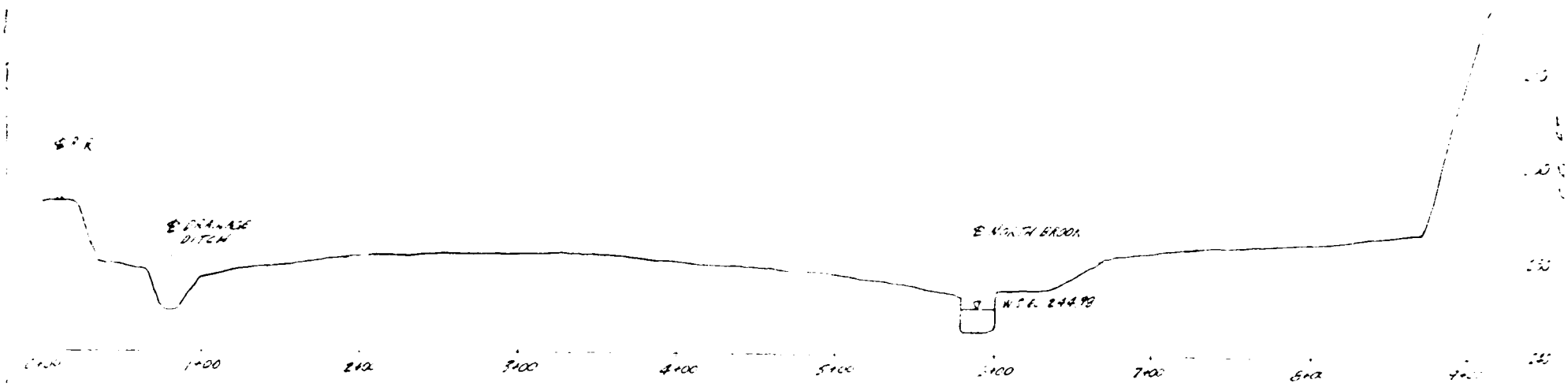
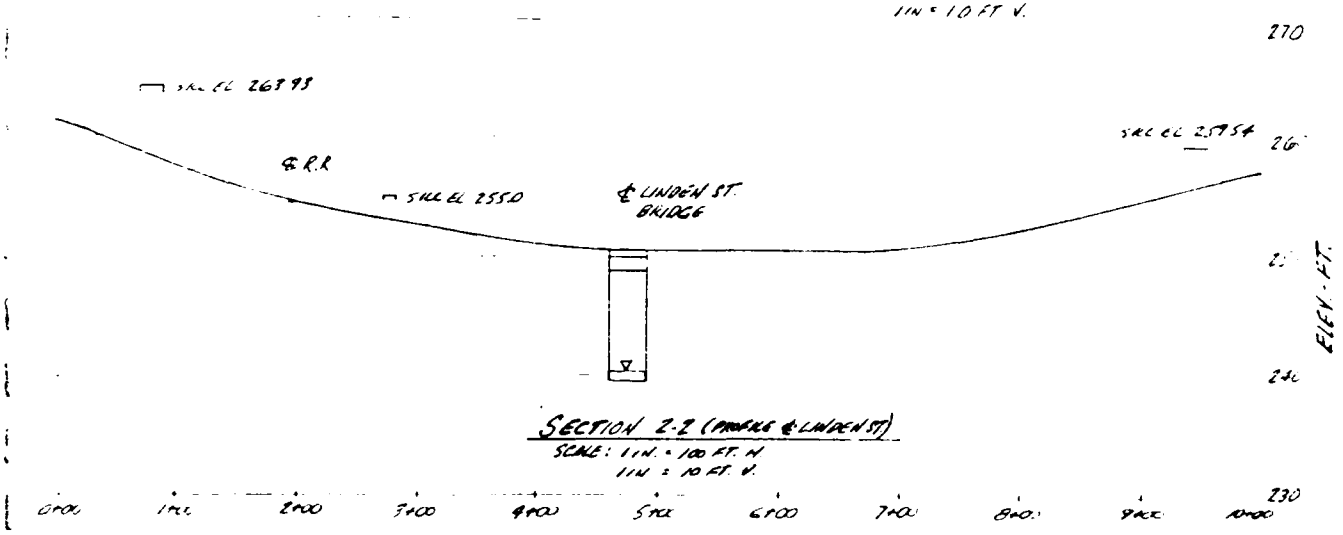


FIGURE B-

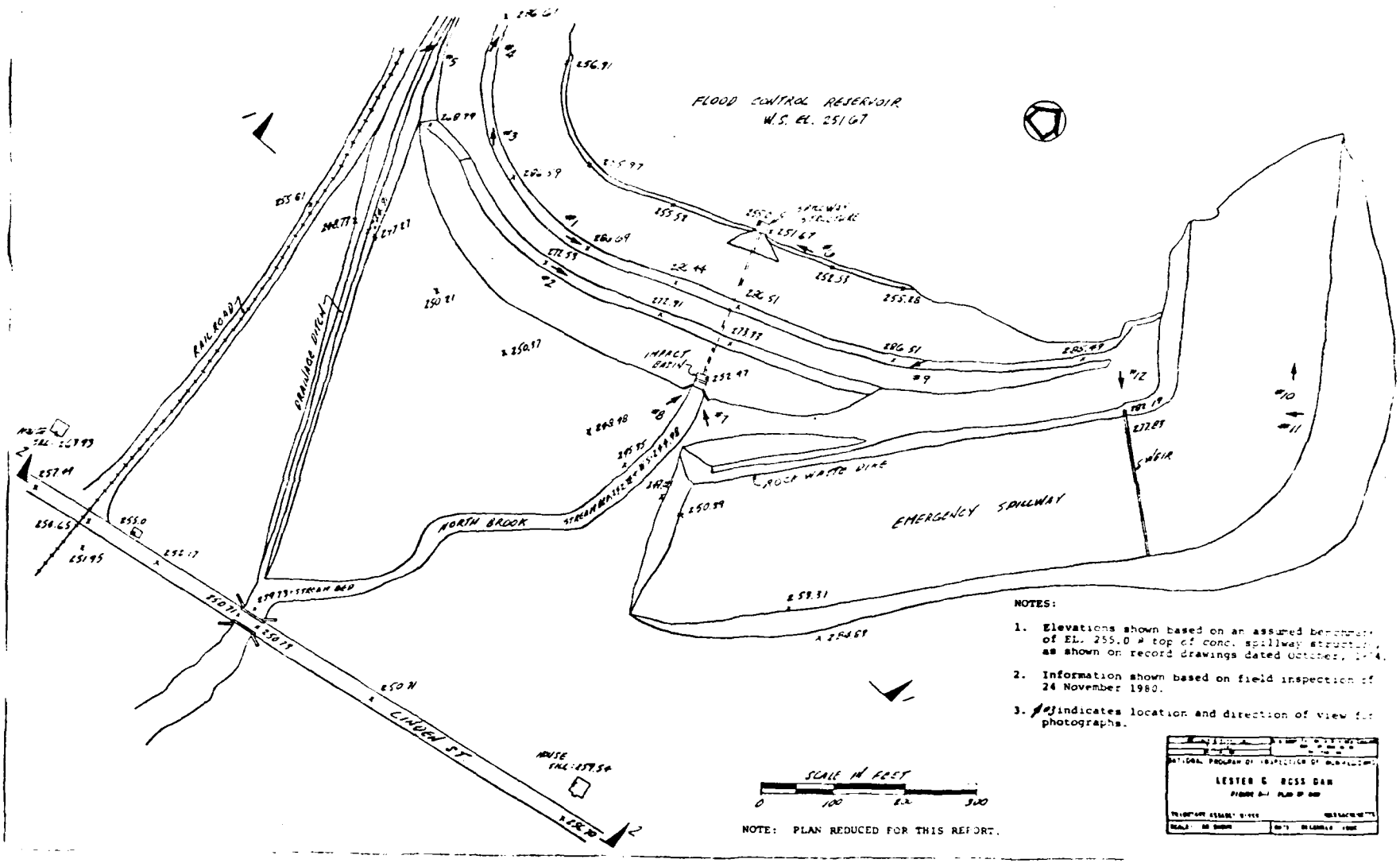


SECTION 1-1 (FR FILE)
SCALE: 1IN = 50 FT H.
1IN = 10 FT V.



SECTION 2-2 (PARALLEL ℄ LINDEN ST)
SCALE: 1 IN. = 100 FT. H
1 IN = 10 FT. V.

[illegible]	[illegible]
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	
LESTER G ROSS DAM	
FIGURE 5-3 SECTIONS THROUGH DOWNSTREAM CHANNEL	
TRIBUTARY ASSABET RIVER	MASSACHUSETTS
SCALE AS SHOWN	DATE DECEMBER, 1980



NOTES:

1. Elevations shown based on an assumed benchmark of EL. 255.0 @ top of conc. spillway structure, as shown on record drawings dated October, 1974.
2. Information shown based on field inspection of 24 November 1980.
3. #/→ indicates location and direction of view for photographs.

NOTE: PLAN REDUCED FOR THIS REPORT.

NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS

LESTER C. ROSS DAM

PLAN OF DAM

A-6-H Barefoot Brook (Northboro)

1) Mow Dam and Emergency Spillway

2) Remove trash and debris from around Riser

3) Remove small growth from U/S Rip-Rap

A-6-F Brewer Brook (Berlin)

1) Replace and secure manhole cover and repaint trash rack

2) Cut brush from both sides of Dam

3) Repair washout at access road 30 cu. yds. of gravel

LESTER ROSS SITE (BERLIN) MAY, 1980

1) Apply approved weed killer on Rip-Rap areas

2) Place new Metal Gate @ R.R. - RX 62 with 3-4" x 4" x 6' lally columns alongside embedded in concrete (Gate supplied by WRC to be picked up at Clinton Yard)

3) Clean debris at Riser and Impact Basin

4) Remove growth growing in Rip-Rap areas

5) Remove growth from Rip-Rap areas, cut bush on Toes both sides of Main Dam

6) Cut growth in outlet channel and outlet of E.S.

7) Replace and secure catch basin grate at 61 + 04, also replace Rip-Rap in the vicinity of drain - clean the 36" culvert

8) Place on top and end of dam grave 100 cu. yds.

DELANEY COMPLEX (STOW)

1) Fertilize main Dam areas 10-10-10 (400 #per A) 7.3 acres

2) Install new metal gate at entrance; make necessary adjustments at old entrance (Gate furnished by WRC to be picked up at Clinton Yard)

3) Clean debris at Riser - caulk the outlet end of conduit

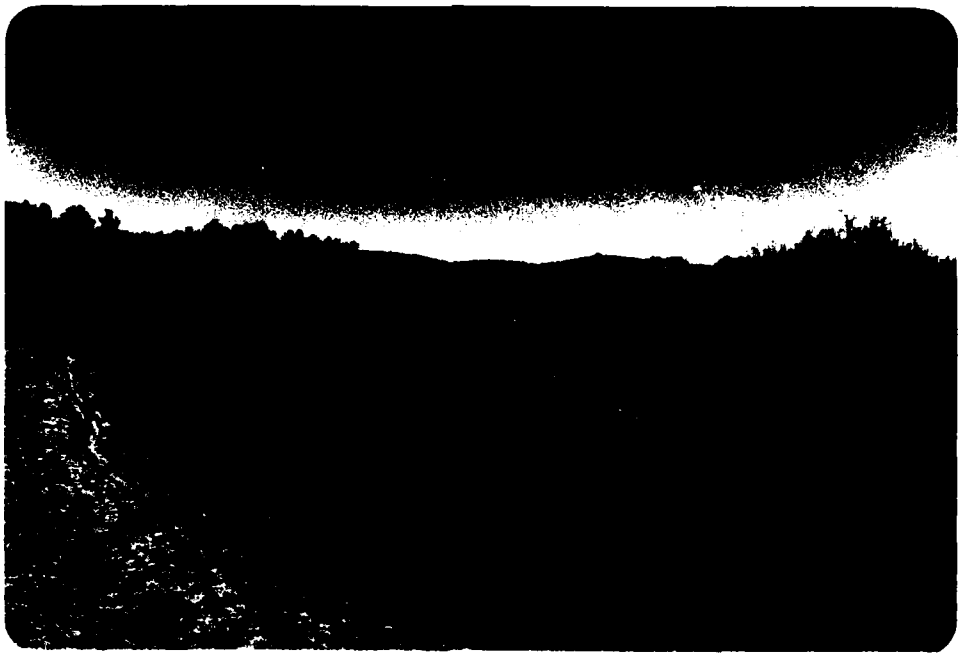
APPENDIX C

PHOTOGRAPHS

Note: Location and direction of photographs shown on Figure B-1 in Appendix B.

NO. 1 CREST OF DAM, TOWARDS EMERGENCY SPILLWAY AND LEFT ABUTMENT

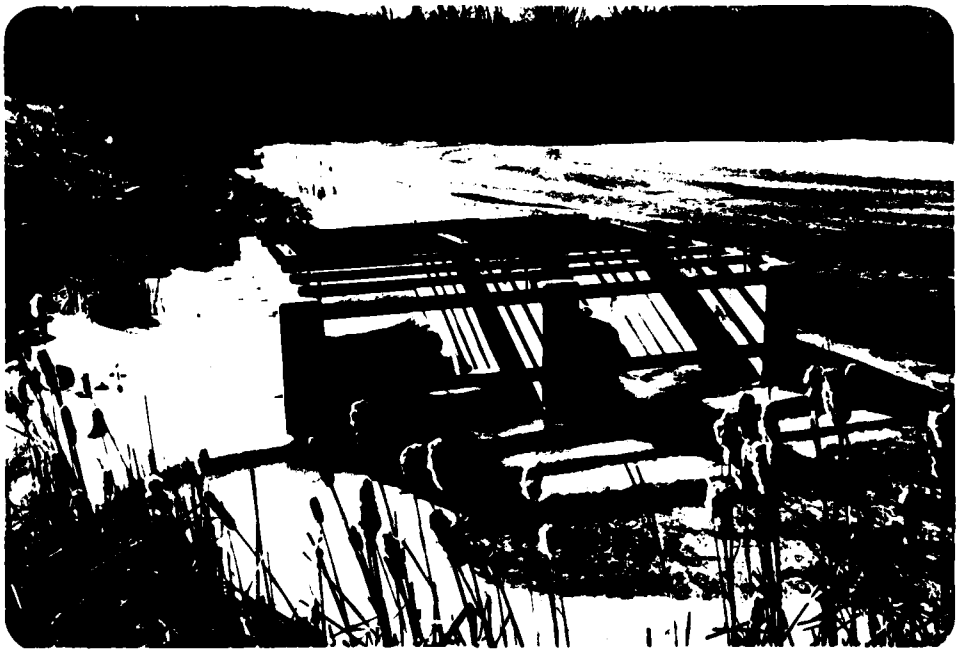
NO. 2 DOWNSTREAM SLOPE OF DAM AND TOP OF BERM (APPROXIMATE EL 273)



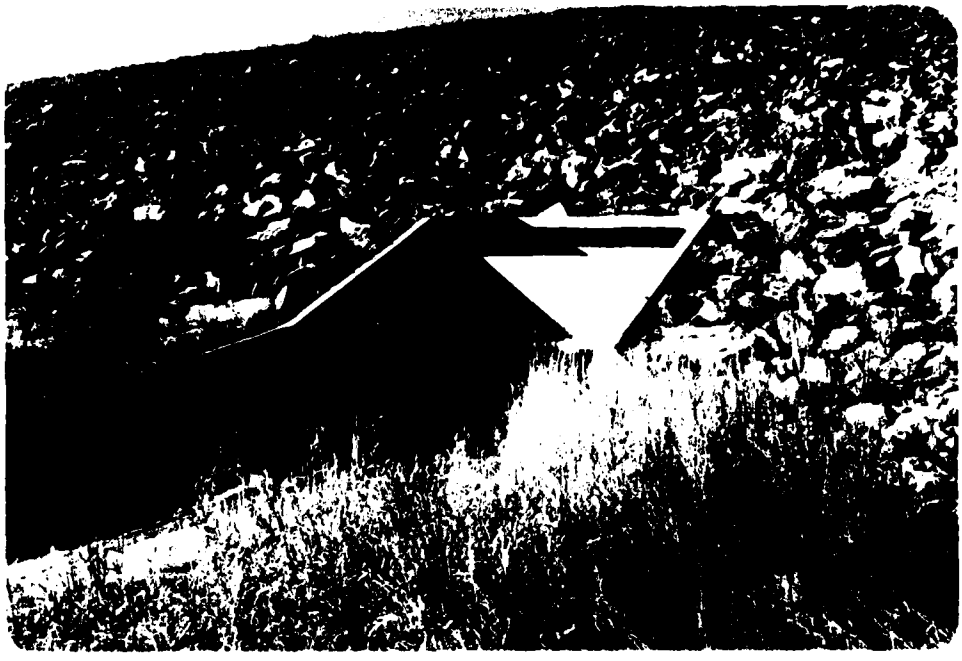
NO. 3 UPSTREAM SLOPE OF DIKE, AT TRANSITION ZONE

NO. 4 CREST AND DOWNSTREAM SLOPE OF DIKE

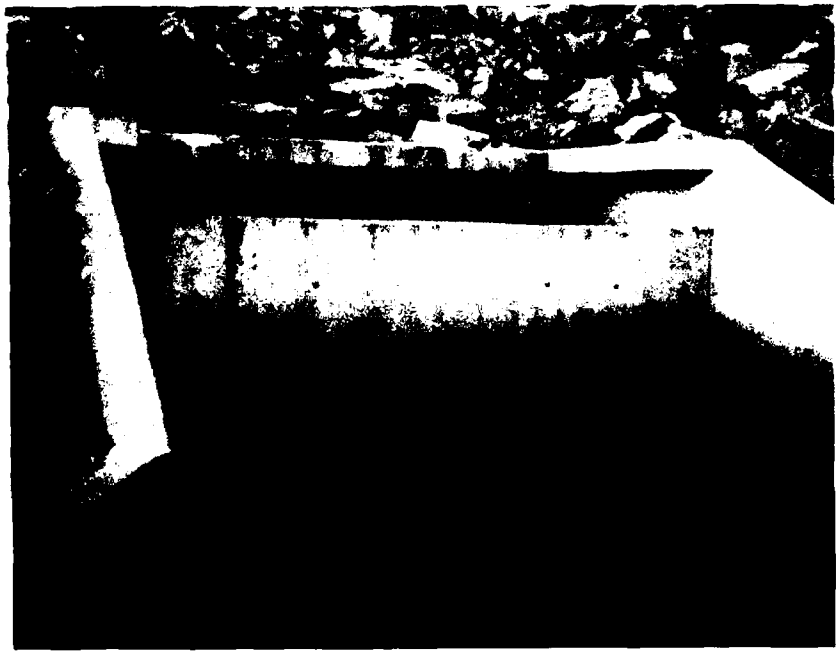
NO. 5 OUTLET FROM FOUNDATION DRAIN, DOWNSTREAM TOE OF DIKE



NO. 6 DROP INLET STRUCTURE



NO. 7 IMPACT BASIN AT OUTLET DISCHARGE



NO. 8 DETAIL OF IMPACT BASIN AT OUTLET DISCHARGE

NO. 9 DISCHARGE CHANNEL BELOW SPILLWAY/OUTLET

NO. 10 UPSTREAM VIEW OF EMERGENCY SPILLWAY CHANNEL

NO. 11 DOWNSTREAM VIEW OF EMERGENCY SPILLWAY AND LEFT ABUTMENT OF DAM

NO. 12 WEIR ON EMERGENCY SPILLWAY

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

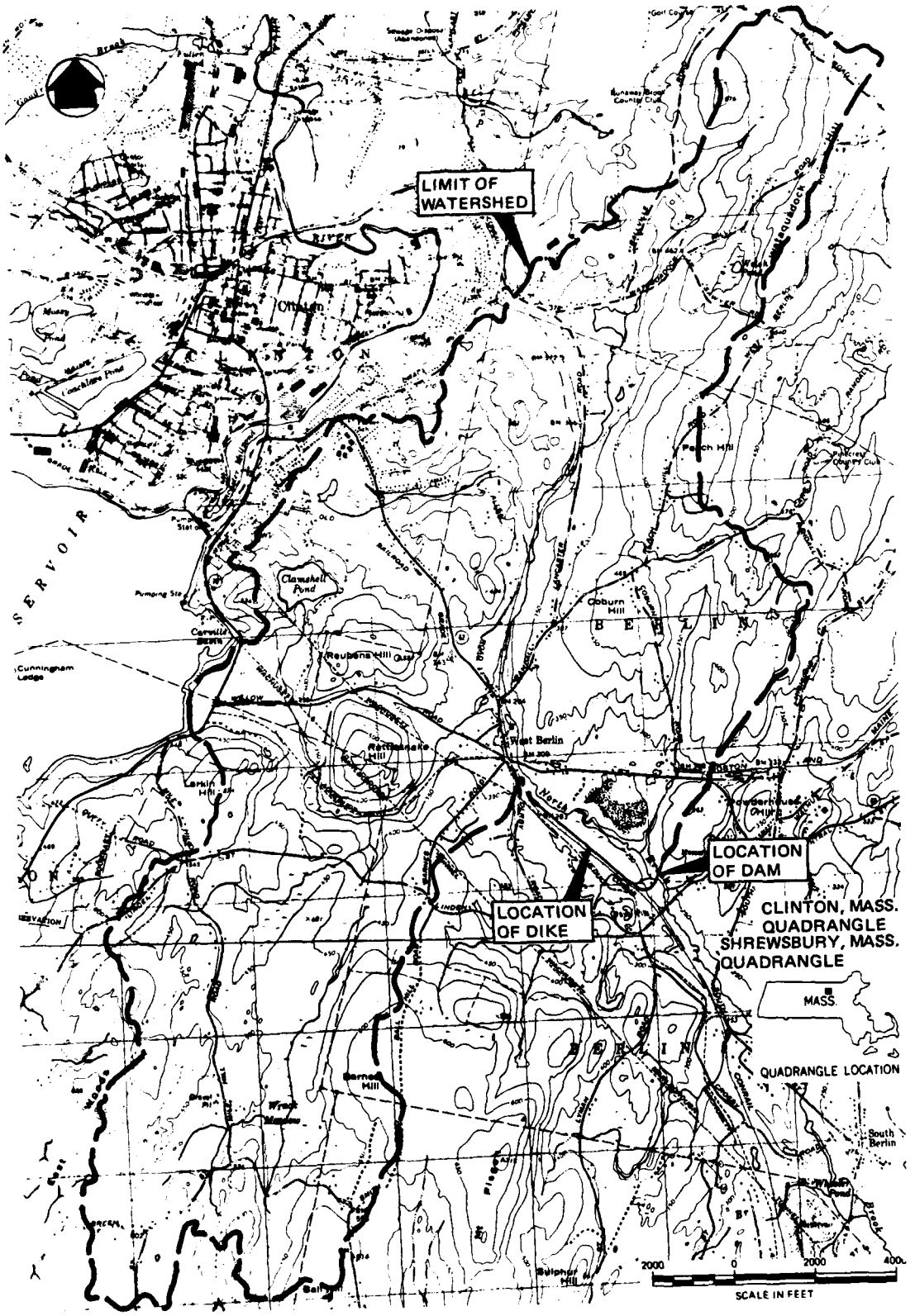


FIG. D-1 DRAINAGE AREA MAP

LESTER G. ROSS DAM

(I) Test Flood, Storage & Storage Function

1- Total Drainage Area - 9.3 mi^2

2- Pond(s) Area: .04 + .02 + .02 = 0.08 mi^2
Swamp(s) Area: .22 + .14 + .05 = 0.41 "
Total Area Pond(s) & Swamp(s): 0.49 "

$$\%\ \text{Ponds \& Swamps} = \frac{0.49}{9.3} = 5.3\%$$

3- $\frac{715-277}{25100} = .01745$; $\frac{640-277}{25000} = .01452$ } Say Ave Slope = 1.6%

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be between "Rolling" and "Flat & Coastal", and taken at 1400 c.f.s./mi²
Size Class: Interm.; Hazard Pot.: Signif.; Spill. Des. Flood: ½ to Full PMF
Use: Test Flood = Full PMF

5- Test Flood Inflow = (1400) 9.3 = 13,000 c.f.s.

6- Pond Storage*
The pond area is 0.20 sq. mi. at elev. 277.5'
Based on a const area, storage increases at ac. feet per foot of depth increase.
*See Curve based on design data.

7- Spillway crest elev. is 251.0

8- Storage Functions are based on $Q_{out} = Q_{in}\left[1 - \frac{S_{out}}{R}\right]$
S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

S (in inches) = $12D\left(\quad\right) =$ D; R = 6hr rain of storm

D = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood & ½ PMF - if needed)

$*F_{TF} = 13000 - 684\ S$	= D
$*F_{½\,PMF} = 6500 - 684\ S$	= D

*S to be evaluated using stage-storage curves

(II) Discharge Relations

A - Spillway

1- Inlet Weir Control

4 weirs - 5'6" long each - curved crest - C = 3.33

$Q_1 = 73.26\ H^{1.5}$, Crest el. 251.0

Res El.	255	260	265	270
H_1	4	9	14	19
Q_1	150	220	270	320

2- Pipe Control

Losses - Ent. #1, Area 11'x4' = 44', $h_L = 0.5 \frac{V_1^2}{2g}$

Direct. Change, $h_L = 1.0 \frac{V_1^2}{2g}$

Ent. #2, Area 12.56 ft², $h_L = 0.5 \frac{V_2^2}{2g}$

Exit Loss, $h_L = 1.0 \frac{V_2^2}{2g}$

Pipe Loss, $h_f = .019 \frac{217}{4} \frac{V_2^2}{2g}$

Impact Basin, Area = 16(2.67) + 2(3.33) + 4.58(14.67) =
= 116.6 ft², $h_L = 1.5 \frac{V_3^2}{2g}$

$V_1^2 = V_2^2 \left(\frac{12.56}{44}\right)^2 = .0815\ V_2^2$, $V_3^2 = V_2^2 \left(\frac{12.56}{116.6}\right)^2 = .0116\ V_2^2$

$H_2 = \Sigma h_L = \frac{V_2^2}{2g}\left[1.5(.0815) + 2.531 + 1.5(.0116)\right] = 2.67 \frac{V_2^2}{2g}$

$V_2^2 = 24.12\ H_2$, $V_2 = 4.911\ H_2^{1/2}$, $Q_2 = 61.68\ H_2^{1/2}$

℄ Outlet to Stilling Basin @ el. 245.5 - use for trial H_2

Res. El.	260	265	270	278	280	284	286
Trial H_2	14.5	19.5	24.5	32.5	34.5	38.5	40.5
Trial Q_2	230	270	310	350	360	380	390
Corrected H_2	13.5	18.5	23.5	31.0	33.0	37.0	38.5
Final Q_2	230	270	300	340	350	370	380

(II) Discharge Relations - Cont.

B.- Channel Just Below Spillway

Trap. channel; 2:1 sides; 16' wide bot.; S = 0.4%, Inv. el. 243.5

$n = .045$; $V = \frac{1.49}{.045}(.004)^{1/2} R^{2/3} = 2.094 R^{2/3}$; $A = y(16+2y)$; $P = 16 + 4.47y$

y	A	P	$R^{2/3}$	V	Q	El. Water
2	40	24.9	1.37	2.87	115	245.5
4	96	33.9	2.00	4.19	403	247.5
6	168	42.8	2.49	5.20	875	249.5
8	256	51.8	2.90	6.08	1556	251.5

C- Emergency Spillway

Trap. channel, 200' wide, conc. sill @ el. 277.5
appr. slope 2%, disch slope 3.5% - steep slope
Crit depth @ sill - ignore side slope area

$Q_c = 3.09(200) H_c^{1.5} = 618 H_c^{1.5}$

Res. El.	278	280	282	284	286
H_c	0.5	2.5	4.5	6.5	8.5
Q_c	220	2440	5900	10240	15310

(III) Low Level Discharge

Res. @ el. 251.0, Remove stoplogs, opening 3' wide x 5'-8" high

Ref.: V.T. Chow "Open Chan Hydr." Fig 17-29; Res el. 251: Q = 3(42) = 126 cfs (Max Disch.)
Res el. 250: Q = 3(30) = 90 cfs Ave flow 108 cfs

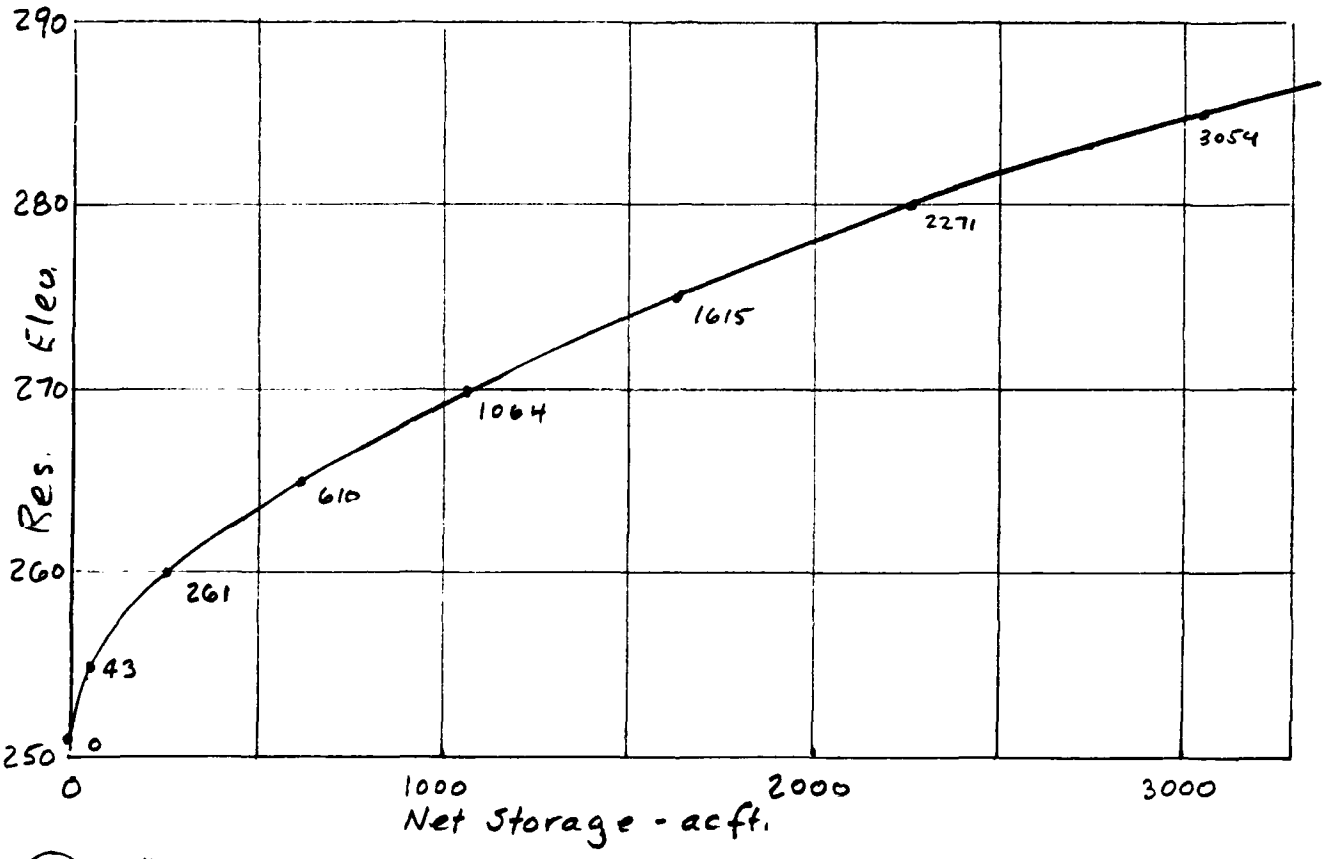
*Time to Lower Res 1 foot = $\frac{14(43560)}{108(3600)} = 1.57$ hours

*Area of Res ≅ 14 acres with res. at el. 251. Value taken from SCS design comps.

Note: Constr. dwgs for dam indicate that a bolted channel retains the top of the stoplogs in place. Stoplog removal could be impeded by this, especially under any depth of water above el. 251±.

(IV) Stage - Storage Relation

Data taken from U.S.S.C.S. design sheets. Zero storage taken at el. 251.0, and total storage reduced by 57 ac.ft. for sediment storage.

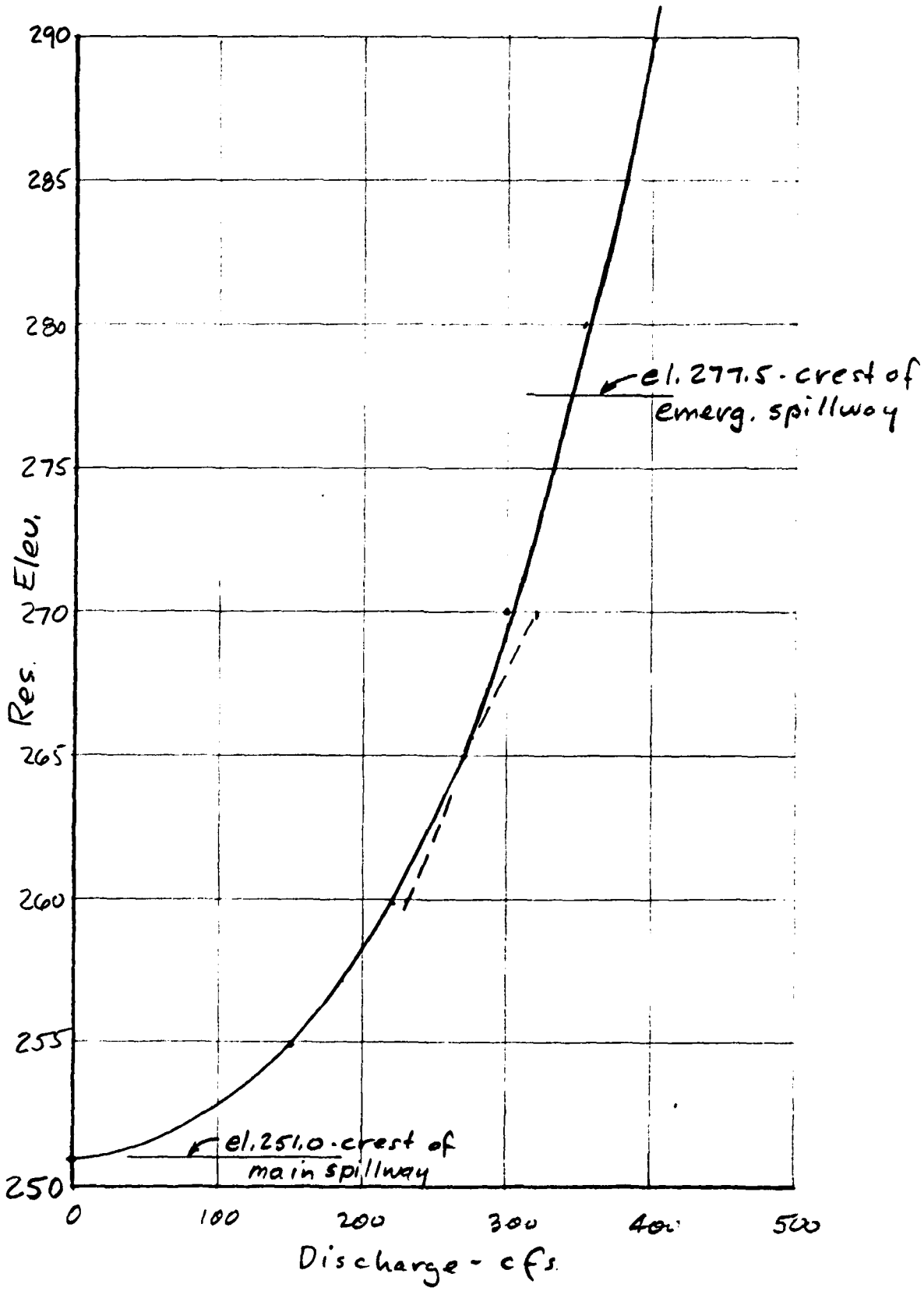


(V) "S" & Storage Function vs Res El.

$$\text{"S" (inches)} = \text{Net Stor. (ac. ft.)}\left[\frac{12}{9.3(640)}\right] = \text{N.S.}(.002016)$$

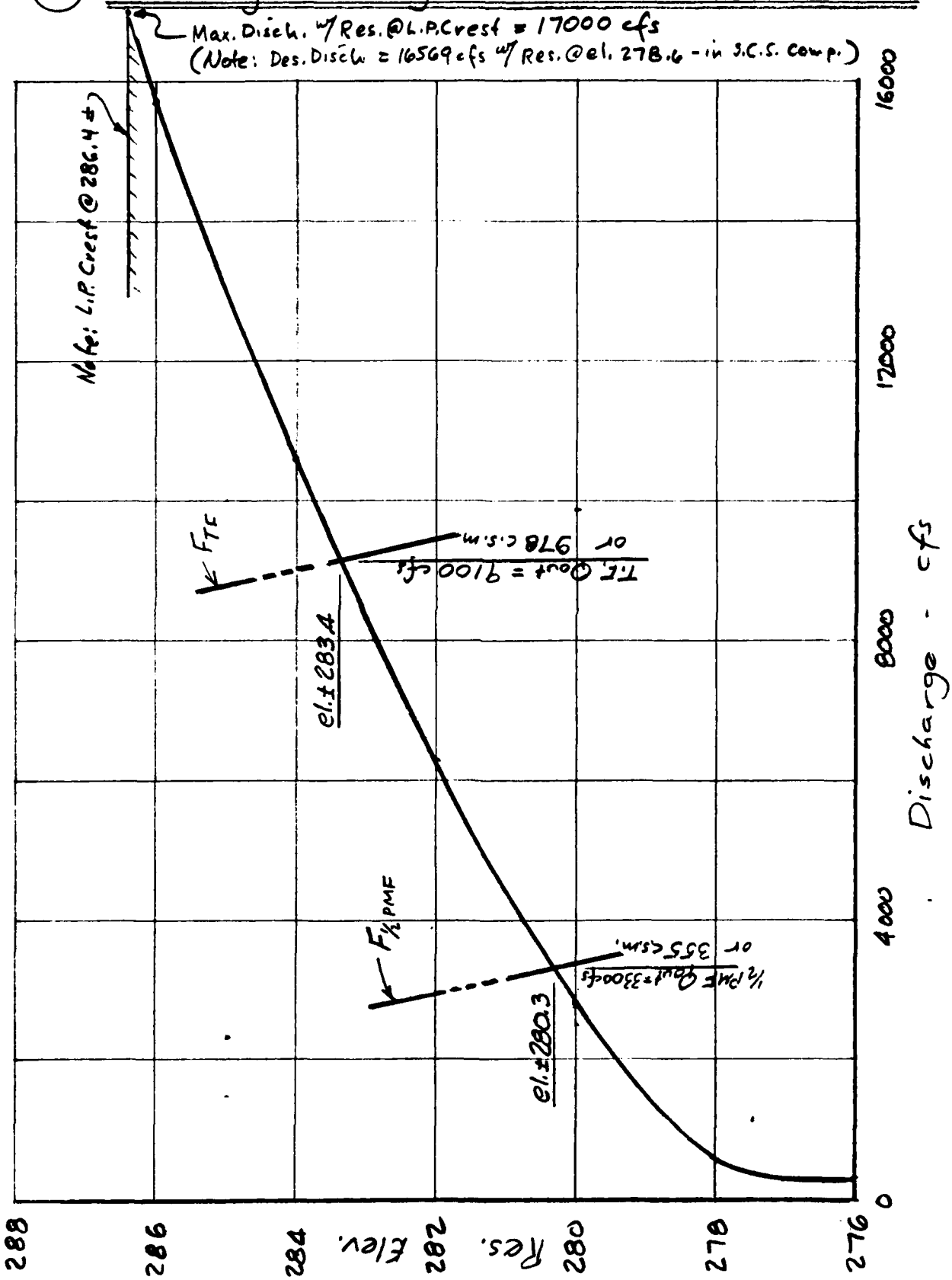
Res. El.	Storage	"S"	F_{TF}	$F_{½PMF}$
285	3054	6.16	8790	2290
280	2271	4.58	9870	3370
275	1615	3.26	10770	4270
270	1064	2.14	11530	5030
265	610	1.23	12160	5660
260	261	0.53	12640	6140
255	43	0.09	12940	6440
251	0	0	13000	6500

(VI) Main Spillway Discharge vs Reservoir Elevation



Project Nat. Review of Non Fed. Dams Acct. No. 7252 Page 6 of 8
Subject Worcester County, Mass Comptd. By LEB Date 12/19/80
Detail LESTER G. ROSS DAM Ck'd. By MEM Date 12/23/80

(VII) Discharge & Storage Function vs Reservoir Elev.



METCALF & EDDY, ENGINEERS

NONREPRODUCIBLE GRID FORM 145

(VIII) Failure of Dam

A- Peak Failure Flow:

Pond Elevation - 283.4 T.F. Elev.
Toe Elevation — 254.2 Tailwater at 9100 cfs
Y_o = 29.2

Dam Length Subject to Breaching $\cong 3Y_o \cong 121'$

$W_o = 40\%(\quad)$

$$Q_{P_1} = 1.68\, W_o\, (Y_o)^{1.5} = 1.68(121)\,(29.2)^{1.5} = 32{,}100 \text{ cfs}$$

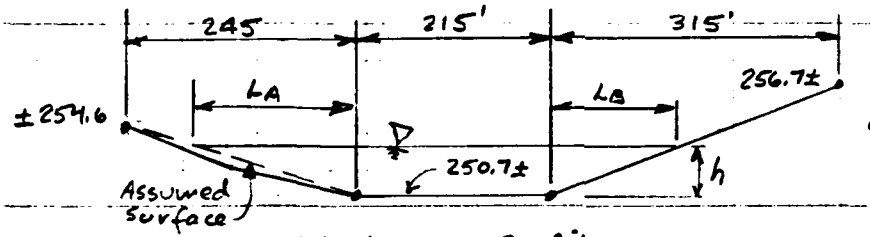
Continuing Spill. Disch.: 9,100 (Main & Em. Sp.ll)
Peak Failure Flow: 41,200 cfs

B- Storage Volume Released:

Storage Above Spillway } see (IV)
Storage Below Spillway }

Total Storage to el. 283.4: ± 2750 ac. ft.
" " " el. 254.2: ± 40 " "
Storage Released : 2710 " "

C- Channel Hydraulics:



Linden St. Profile

Assume failure flow just below dam is controlled by flow over Linden St. as broad weir.
$Q = 2.55\, h^{1.5}$
Plus culvert flow - see VIII - E

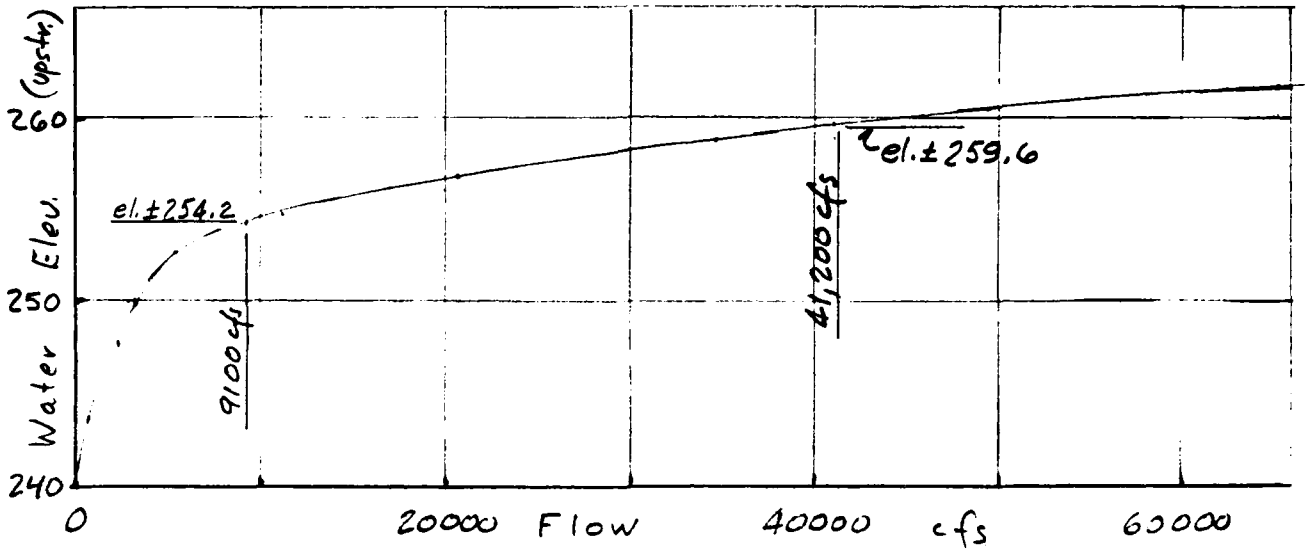
$$L_A = \frac{h}{3.9}(245) = 62.8h \;;\; L_B = \frac{h}{6.0}(315) = 52.5h$$

$$Q_c' = 215(2.55)h^{1.5} + L_A\frac{h}{2}2.55\left(\frac{h}{2}\right)^{0.5} + L_B(2.55)\left(\frac{h}{2}\right)^{1.5} = 548.2h^{1.5} + 104.0h^{2.5}$$

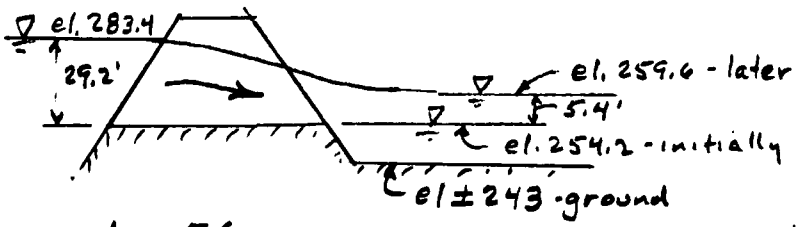
h	Q_c'	+	Q_E	=	Q_c	Elev. Water (=250.7 + h)
2	2140	+	3410	=	5,550	252.7
4	7710	+	"	=	11,120	254.7
6	17230	+	"	=	20,640	256.7
8	31230	+	"	=	34,640	258.7
10	50230	+	"	=	53,640	260.7
11	61740	+	"	=	65,150	261.7

Failure of Dam - Cont.

D. Water Elev. vs Flow Rate @ Linden St.



E - Added Reduction to Failure Flow



Ref.: Davis, "Hndbk of Appl. Hydr." pg 1224, Table 11

$d/H = \frac{5.4}{29.2} = .185$; $n = 0.988$; $Q_2 = Q_1(n)^{1.5} = 32100(.988)^{1.5} = 31500$ cfs.

Total peak flow beyond Linden St. = 31500 + 9100 = 40,600 cfs. with peak elev. at Linden St of el. ± 259.6.

Failure increases vol. of water between dam & Linden St. by:

ΔVol. #1 = 5.4' (700' length)(650' width) ≃ 56.4 ac ft.

North Brook valley is ± 14000 ft bet. dam & Assabet R. Assume failure raises water level ± 5.4' over entire length* with average width of 650'

ΔVol. #2 = $\frac{14000}{700}(56.4)$ = 1128 ac ft.

Flow at Assabet R. = $31500\left(1 - \frac{1128}{2710}\right) + 9100 = 27500$ cfs.

* Prior full PMF flow would have already raise stream levels considerably.

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

LESTER G. ROSS DAM

NOT AVAILABLE AT THIS TIME

END

FILMED

8-85

DTIC